SELF-ASSESSMENT REPORT ON THE QUALITY OF EDUCATION IN THE DOCTORAL SCHOOL

Szkoła Doktorska Wojskowej Akademii Technicznej imienia Jarosława Dąbrowskiego

Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego

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VISITING CARD

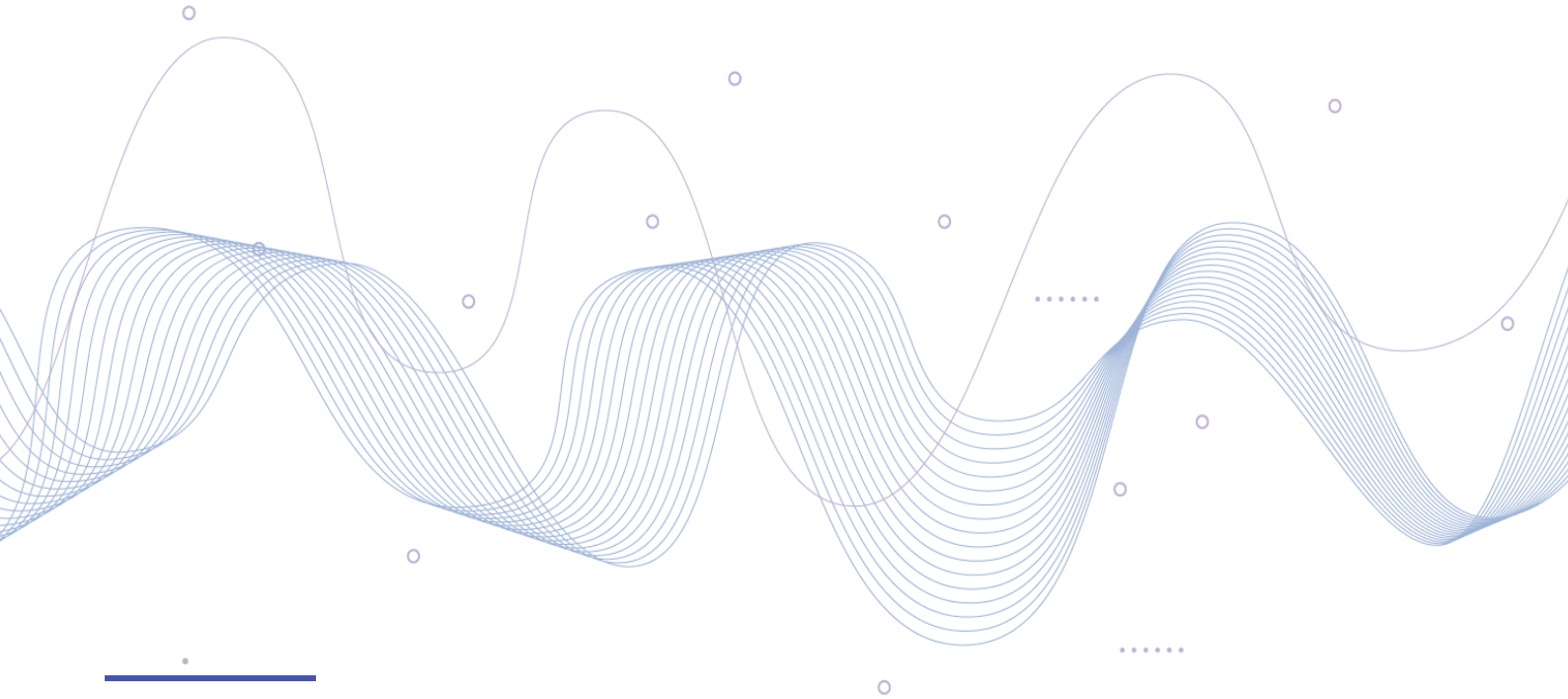
Basic Information about the Doctoral School

Year of Creation

2019

Institution running the doctoral school

Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego



Field of Education	Education Disciplines
Natural sciences	chemical sciences
Engineering and technology	information and communication technology materials engineering mechanical engineering civil engineering, geodesy and transport automation, electronics, electrical engineering and space technologies
Social sciences	security studies

Name/Scope of the Education Program (PL)	Name/Scope of the Education Program (EN)
Program kształcenia SDR WAT - I	Curriculum at the Doctoral School Military University of Technology - 2019
Program kształcenia SDR WAT - II	Curriculum at the Doctoral School Military University of Technology - 2020
Program kształcenia SDR WAT - III	Curriculum at the Doctoral School Military University of Technology - 2021
Program kształcenia SDR WAT - IV	Curriculum at the Doctoral School of the Military University of Technology - 2022
Program kształcenia SDR WAT - III zm	Curriculum at the Doctoral School Military University of Technology - 2021 updated
Program kształcenia SDR WAT - IV zm	Curriculum at the Doctoral School Military University of Technology - 2022 updated
Program kształcenia SDR WAT - I zm	Curriculum at the Doctoral School Military University of Technology - 2019 updated
Program kształcenia SDR WAT - II zm	Curriculum at the Doctoral School Military University of Technology - 2020 updated
Program kształcenia SDR WAT - V	Curriculum at the Doctoral School of the Military University of Technology - 2023
Program kształcenia SDR WAT VI	Curriculum at the Doctoral School of the Military University of Technology - 2024

Characteristics of the Doctoral School

The Doctoral School (DS) of the Military University of Technology (MUT) was established in 2019 and is the first and largest, in terms of the number of disciplines and doctoral students, doctoral school in the Ministry of National Defence (MoD). The formula of its activity makes it possible to support interdisciplinarity in scientific research and to acquire advanced qualifications and competences by doctoral students, which are valuable especially for the economy and national defence. It also promotes the achievement of the synergy effect of education and conducting scientific research as part of the doctoral dissertation prepared by the doctoral student.
The characteristics of the Doctoral School include such aspects as: an innovative education system, an Individualized Research Plan (IRP) with the possibility of using modern research infrastructure, as well as ensuring the stability of financial support (doctoral scholarship). In addition, it is also important to create conditions for national and international exchange, to provide evaluation that supports the development of doctoral students and space for integration, support for self-government, entrepreneurship and doctoral students' own initiatives.
The mission of the DS is to provide optimal conditions for the implementation of the education process preparing doctoral students to independently conduct innovative scientific research, promote the quality and innovation, develop research and academic competences of doctoral students, promote ethics in the scientific process, prepare innovative research and obtain a doctoral degree. It is based on the synergy of five basic areas: education, science, innovation, cooperation and upbringing. In the course of the DS's operations in 2020 and 2024, the two DS Strategies were developed, which are a development of the strategic goals set in the MUT Strategy as part of the Strategic Development Directions and strategic goals adopted for the DS.
The DS creates a space for education and conducting research in 3 fields of science and 7 scientific disciplines in the field of Engineering and Technical Sciences, and Social and Natural Sciences and Social Sciences. The scope and subject matter of doctoral theses are a consequence not only of the potential of the MUT, but also of the specificity of the University, conducting investigations and research projects in the field of advanced defence technologies and the so-called dual-application, and this is a feature that distinguishes the DS from other schools in the state.
The DS is well "recognizable" in the country, in the years 2019-2025 656 candidates applied for admission. A total of 415 people were admitted. A, almost 61% of the candidates are outstanding graduates of master's studies graduated with a very good result. In addition, within the five editions of the "Implementation Doctorate" (program of the Ministry of Science and Higher Education), 14 people out of 21 candidates were admitted, candidates to program are recruited from the defence sector and institutions. The DS enables officers to improve their qualifications outside the MoD training system, at that moment, 124 officers are educated in the DS, it is 41% of the total number of PhD students.
To the report date (10.09.2025), 258 PhD students were educated in the DS, while the academic year 2025/2026 began with 302 PhD students.
The DS education system is focused on individualism and support of the doctoral student in the field of research. While the first year of education includes common classes for all doctoral students, from the third semester onwards, classes are carried out according to the Individual Educational Program (IEP). As a consequence, classes are conducted in very small groups (even one-person), in the form of seminars in the "master-young researcher" partnership formula. About 6500 teaching hours are carried out annually. The curriculum and the rules of recruitment are annually analysed, updated and accepted by the MUT Senate.
The process of preparing a doctoral dissertation and the scientific activity plan is determined by the Individual Research Plan (IRP), which is the basis for monitoring and evaluating the doctoral student's progress. The evaluation is provided by such forms as: semester seminars and reports, as well as mid-term evaluation. Seminars are organized by the DS, university departments or institutes related to the research conducted by a doctoral student. Scientific supervision provided by the supervisor includes: a semester assessment of the student’s scientific development, participation in the preparation of IEP and IRP and ongoing monitoring of their implementation etc.
By providing administrative, financial and organizational assistance to students, the DS provides: financial service (over 10 million scholarships annually), support for projects of the Ministry of Science and Higher Education (over 1 million), the National Agency for Academic Exchange, supervision over the Students' Government, and the operation of the USOS, POL-on, SAP, Webcon systems.
As at the date of preparation of the report, 44 doctoral students submitted their doctoral dissertations and formally completed the process of education in the DS, including 30 who have already obtained a doctoral degree, and 13 dissertations were awarded by the councils of scientific disciplines. The DS graduates have made a significant contribution to the scientific activities of the university and popularizing research, they published 331 scientific papers, including 13 in journals for 200 points, 63 for 140 and 64 for 100 points (list of the MS&HE). They also participated in 107 research projects and 167 scientific conferences, receiving 40 awards and distinctions.
The Education Quality Assurance System operates in the DS as a transparent set of procedures, opinions, analyses and conclusions on the functioning of the education process and indicating the directions of corrective actions. Within the quality system, the DS dean's office has been ranked in first place in the assessment of MUT dean's offices for several years.
An important role in the education process played the DS Council, which is an advisory body and supporting the DS director in education and doctoral matters. It consists of representatives of the Councils of Scientific Disciplines, faculties involved in the education of doctoral students and the Students' Government.
In carrying out its tasks, the DS for five last years has developed drafts of 24 resolutions of the MUT Senate, 67 Rector decisions, and 52 of the Director. The DS organizes annually a series of meetings for candidates, doctoral students, supervisors etc. In addition, school provides doctoral students with access to information and documents about the education process, through the DS website and Teams created in MS Teams.

Additional Information about the Doctoral School

Educating Staff

Numerical data for the evaluation period

Educating Staff	Instructors	Supervisors	Assistant Supervisors
Number of people	286	146	117

Doctoral Students

Number of doctoral students (total): 361

Recruitment during the evaluation period	2019/ 2020	2020/ 2021	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	Total
Number of recruited doctoral students	45	64	59	66	61	66	361
Number of doctoral students who completed the doctoral school	19	21	4	0	0	0	44
Number of doctoral students removed from the doctoral student list	18	17	13	6	4	1	59

Mid-term evaluation results	Positive	Negative
Number of Doctoral Students	194	6

Educational Programs	Number of Doctoral Students
Curriculum at the Doctoral School Military University of Technology - 2019	0
Curriculum at the Doctoral School Military University of Technology - 2020	0
Curriculum at the Doctoral School Military University of Technology - 2021	0
Curriculum at the Doctoral School of the Military University of Technology - 2022	0
Curriculum at the Doctoral School Military University of Technology - 2021 updated	54
Curriculum at the Doctoral School Military University of Technology - 2022 updated	66
Curriculum at the Doctoral School Military University of Technology - 2019 updated	33
Curriculum at the Doctoral School Military University of Technology - 2020 updated	54
Curriculum at the Doctoral School of the Military University of Technology - 2023	61
Curriculum at the Doctoral School of the Military University of Technology - 2024	66

Additional Numerical Data on Doctoral Students

Number of foreign doctoral students	2
Number of doctoral students with disabilities	3
Number of doctoral students in the Implementation Doctorate program	11
Number of doctoral students in the EU program	0
Number of doctoral students employed by the institution running the doctoral school as academic teachers or research staff	6

Graduates

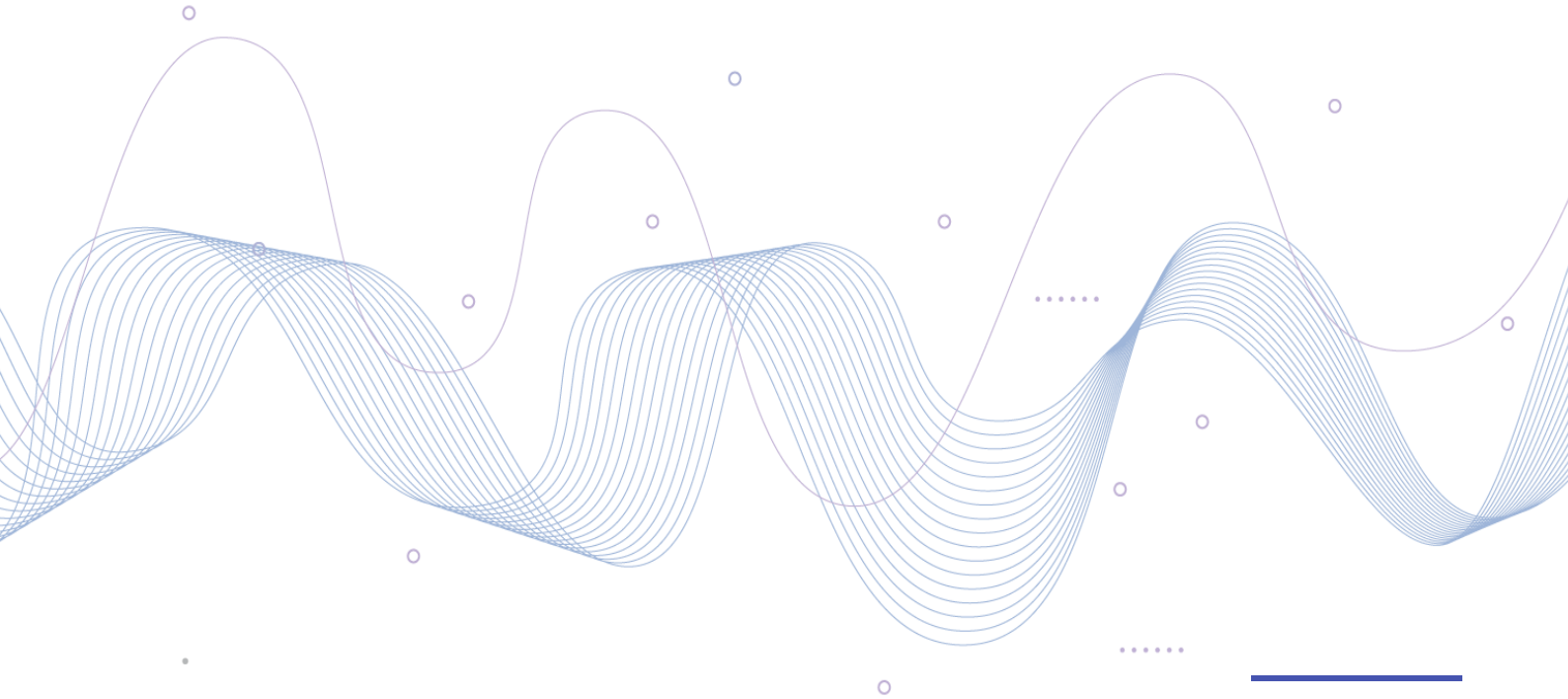
Numerical data for the evaluation period

Number of graduates who applied for initiation of proceedings for the award of a doctoral degree	38
Number of doctoral students who completed the doctoral school	30

INFORMATION ON THE ENTITY'S COOPERATION WITH THE DOCTORAL STUDENTS' COUNCIL

Cooperation between the MUT and the Doctoral Students Government (DSG) plays a key role in shaping the academic community and improving the conditions for education and scientific research by students. It is based on a dialogue between the MUT representatives and doctoral students, which allows for a better understanding of their needs and expectations. Participation of doctoral students' representation in the decision-making and strategic processes of the Doctoral School (DS) is carried out as part of their participation in the work of the MUT Senate, the Library Council, the University Commission, the Quality System and the DS Council. In addition, the Chairman of the DSG participates in monthly Rectors' meetings, presenting information on the doctoral students' activities.
In 2024, the DS took over the care and administrative and financial support of the DSG from the Vice-Rector for Student Affairs, ensuring the right conditions for its functioning. Not only the basic documents regulating the school's activities, e.g. DS Regulations, the curriculum, but also documents related to the implementation of education, e.g. templates of documents prepared by doctoral students, are agreed with the DSG. The DS supports students in organizing various types of projects, including annual school integration meetings (DS Picnic) and doctoral student conferences, as well as the activities of 3 doctoral students' scientific organisations. Together, occasional meetings and the inauguration of the academic year. As part of the care for foreign students, the DS and the DSG provide assistance in accommodation, insurance and residence procedures. The DS cooperation with PhD students is noticed and highly valued, as evidenced by the results of surveys of the DS students and graduates. In 2023, the DSG "in recognition of the contribution to the development of the MUT's doctoral student community" awarded the DS management personnel.

INFORMATION ON THE DOCTORAL SCHOOL GROUPED BY 8 EVALUATION CRITERIA



1. Adequacy of the education program and individual research plans to the learning outcomes for qualifications at PRK level 8 and their implementation

The education process at the Doctoral School (DS) is conducted on the basis of the Curriculum, including the Individual Education Program (IEP) and the Individual Research Plan (IRP) and is aimed at preparing the doctoral student to obtain a doctoral degree and achieve learning outcomes for qualifications at level 8. Polish Qualifications Framework (PQF). The learning outcomes have been included in the Curriculum (educational program) established by the MUT Senate in three categories of knowledge, skills and social competences and take into account:
- universal characteristics of the first level specified in the Act of 22 December 2015 on the Integrated Qualifications System;
- characteristics of the second level specified in the Regulation of the Minister of Science and Higher Education of 14 November 2018 on the characteristics of the second level of learning outcomes for qualifications at levels 6-8 of the PQF.

On the basis of the above characteristics, 32 effects were formulated, including 7 effects within the area of knowledge, 16 skills and 9 social competences. Giving them appropriate symbols made it possible to assign them not only to the subjects included in the curriculum, but also to other forms of education and various types of activities of students, including scientific ones.
The indicated effects are reflected in the didactic activity, parameterized by ECTS credits and scientific activity, which are subject to continuous evaluation within the DS Quality Assurance System. The curriculum is updated annually by the MUT Senate and its preparation includes consultations among doctoral students, teachers, supervisors and deans. The final version is being analysed by the DS Council and the Doctoral Students Government. As part of the update, new subjects are introduced, outdated ones are removed, curriculum contents number of hours and references to learning outcomes. As part of student didactic activity, in the first year (freshmen) student completes the subjects of the basic module of the curriculum in the amount of 100 hours (9 ECTS) preparing for conducting scientific activity and acquiring the so-called transversal skills. For semesters III-VII, the docstudent develops the IEP aimed at expanding and acquiring new knowledge, skills and social competences. IEP includes subjects selected from the optional module, professional practice in the form of teaching classes or participating in their conduct, or other forms of education, e.g. internships, training carried out in a domestic or foreign scientific institution. In total, The IEP includes 200 hours (21 ECTS credits). The basis of the doctoral student's scientific activity is the IRP, i.e. the plan for conducting scientific research and scientific activity, which is a "scientific roadmap" for the preparation of the doctoral dissertation. The activity includes both disseminating the results of his analyses and scientific research in the form of publications, but also participation in national and international scientific conferences. Support is provided by the implementation of a research internship, study trip and participation in projects, programs and grants. The adopted formula for the implementation of the education process makes it possible to support interdisciplinarity in scientific research and to acquire advanced qualifications and competences by doctoral students. It also promotes the achievement of the synergy effect of education and conducting scientific research as part of the doctoral dissertation prepared by the doctoral student. The interdisciplinary nature of the education process is achieved through: creating interdisciplinary lists of potential supervisors and research topics to be chosen by candidates, multidisciplinary scientific supervision conducted by supervisors representing various scientific disciplines, also by foreign supervisors, implementation of IEP enabling the selection of subjects from various scientific disciplines, not only included in the curriculum, but also offered by domestic and foreign universities, as well as other forms of education, organization of open seminars promoting the exchange of knowledge and experience between participants representing different scientific disciplines, participation of doctoral students in national and international projects, grants, programs with a wide range of research scope.
Interdisciplinary education encourages doctoral students to think critically and take into account different points of view, preparing them for professional and scientific careers.
The Learning Outcomes Coverage Matrix for qualifications at level 8 of the PQF is both a confirmation of the implementation of the planned didactic and scientific activity by the doctoral student, as well as a direction of reference to the adequacy of the curriculum and IEP. Such action ensures the reliability of the implementation and improvement of the education process.

2. Method of verifying learning outcomes for qualifications at PRK level 8

Verification of learning outcomes for level 8 qualifications of The Polish Qualifications Framework (PQF) at the Doctoral School (DS) includes a number of activities aimed at confirming the achievement of learning outcomes assumed for this level. It is conducted in two areas: didactic, related to the implementation of the Curriculum and Individual Education Program (IEP), and scientific related to the implementation of the Individual Research Plan (IRP).
The method of verifying learning outcomes is directly related to the adopted original education system. A novelty is the departure from the traditional form of lectures and forms of crediting, in favour of seminars and workshops and generalized grades (passed, failed), so as to move away from status doctoral student-student, in favour of partnership between a supervisor and a young researcher (doctoral student – young scientist). In addition, the courses are passed during classes or on the date indicated by the tutors, eliminating the need to plan exam sessions. The parameterization of subjects, work experience and other forms of education is provided by the ECTS. A doctoral student who is a disabled person may apply for the adaptation of selected elements of the education process to the specific needs resulting from the degree and nature of the disability. Verification of the assumed learning outcomes, to the extent resulting from the implementation of the education programme, including IEP, is carried out by checking the knowledge acquired by the student, acquired skills and social competences, confirmed by passing subjects, professional practice and other forms of education.
In the first year of education, the student completes the Basic Module comprising 8 subjects preparing for the role of a young scientist and acquiring appropriate organizational, didactic and scientific competencies. For some subjects, the verification of learning outcomes includes additional aspects of validation. For the subjects: Higher Education Teaching and Principles of Conducting Classes, the form of passing the subjects is the presentation by the doctoral student of the most interesting issues related to the subject of the doctoral dissertation for students of the last grades of selected secondary schools. In addition, the subject Research Area Analysis, which is the basis for the preparation of IRP, is carried out in the form of an individual student-supervisor seminar. It includes, an analysis of the state of knowledge, the definition of a research problem and a preliminary definition of the methodology, and is credited by the supervisor on the basis of the evaluation of the report prepared by the doctoral student and the presentation the open seminar. Each subject from the Basic Module has a reference to learning outcomes and in total for all subjects from this module constitutes the first group of outcomes. Education in semesters III to VII is carried out on the basis of the IEP developed by the student in cooperation with the supervisor, and includes subjects selected from the optional modules of the scientific disciplines of the curriculum, professional practice in the form of conducting classes or participating in their conduct, and other forms of education (internships, internships, study trips, training). Importantly, subjects, practice and other forms of education can also be carried out outside the MUT in domestic and foreign institutions. Each form of education included in the IEP is subject to credit. The credit for the internship is made by the head of the faculty internship, where the internship was carried out. In the case of projects carried out outside the MUT, the credit is made by the supervisor on the basis of the doctoral student's report and confirmation of the completion of this form, e.g. a certificate, etc. n order to ensure transparency in the verification of learning outcomes in the first class, the teacher is obliged to present the main curriculum content of the course and the method of passing. One of the annexes to the IEP is a document specifying the learning outcomes to be achieved as a result of the implementation of all forms included in the IEP. This is the second group of learning outcomes.
In the scientific area, the method of verifying learning outcomes is closely related to the implementation of IEP by a student. In this area, the key role in verifying learning outcomes is played by the supervisor, whose role has changed significantly and is directed, from the first year of education, not only to substantive and organizational support of the doctoral student, but also to the evaluation of his progress in the preparation of the doctoral dissertation. The supervisor is person who analyses and evaluates the presentations, semester reports, interim and final reports prepared by the doctoral student, and prepares the semester opinions, the interim and final opinions.
As part of the implementation of IEP, the PhD student is obliged to prepare and present: information on the status of research at each request of the supervisor, presentations at semester seminars, semester reports, interim report, presentation before the mid-term evaluation committee, final report at the end of education and submission of a doctoral dissertation. These projects will form the basis for verifying the learning outcomes expected to be achieved as a result of the IEP.
From the beginning of education, the doctoral student is obliged to systematically inform the supervisor about the progress in the preparation of research and his/her scientific activity (publications, participation in conferences, seminars, symposia, competitions, grants, programs, projects, internships, internships). Such action ensures that the supervisor monitors the progress of the doctoral student in the preparation of the doctoral dissertation on an ongoing basis. If the doctoral student fails to fulfil this obligation, the supervisor may request a committee assessment of the doctoral student's progress in the implementation of the IEP.
Another way of monitoring the progress of the PhD student in the implementation of IEP are doctoral seminars organized in semesters III, V, VI and VII, by DS or by the MUT units related to the education of doctoral students as part of faculty, institute or company seminars. Before each seminar, the student submits a semester report to the supervisor, where presents information on the status of the planned stages of the preparation of the doctoral dissertation and the forms of scientific activity carried out. The supervisor evaluates the semester report and the doctoral student's presentation at the seminar and prepares the semester opinion with the grade. The doctoral seminar at the end of semester VII is carried out in front of the competent Council of Scientific Discipline, being a kind of pass to finalize the doctoral dissertation. Open doctoral seminars give the doctoral student and supervisor the opportunity to receive feedback in the form of comments, suggestions, tips on the conducted research and are an important element of verification in terms of indicating the strengths and weaknesses of the doctoral dissertation.
The quality and effectiveness of doctoral students' education is enhanced by the mid-term evaluation of progress in the preparation of the doctoral dissertation, which is a formal caesura for the implementation of the IEP. In accordance with the criteria established by the Rector, the committee evaluates the implementation of IRP on the basis of the analysis and evaluation of the doctoral student's mid-term report, the supervisor's mid-term opinion, the doctoral student's self-presentation

and the evaluation interview (scientific discussion) with the doctoral student. The result of the positive or negative evaluation together with the justification is not only a verification of the doctoral student's previous work, but also, in the case of a positive evaluation, it may contain recommendations for changes, modifications in subsequent stages of research and preparation of the doctoral dissertation. The submission of a doctoral dissertation with a positive opinion of the supervisor and a final report on the implementation of IEP constitutes a formal completion of education in the DS and at the same time confirmation of the completion of the verification of learning outcomes at this stage.
All the methods of verification indicated in the didactic and scientific area create a transparent, comprehensive and coherent system of verification of the learning outcomes achieved by a student at level 8 of the PQF. Formal confirmation of the verification of learning outcomes is a document introduced by the decision of the Director entitled Summary of learning outcomes assumed to be achieved by the doctoral student as a result of the implementation of the DS education process. This document is prepared by the student on the basis of the learning outcomes specified for the subjects from the basic module (the first group of outcomes), the learning outcomes expected to be achieved as a result of the IEP (Annex to the IEP – group two) and the learning outcomes assumed to be achieved as a result of the IRP (Annex to IRP– group three). It is a matrix, a table of coverage of outcomes for qualifications at level 8 of the PQF with the effects achieved in the process of education. The first summary of learning outcomes is prepared by the student together with the first IEP. In the event of changes to the IEP or IRP, the doctoral student is obliged to update the statement – annexes.
It should be emphasized that the individual stages of verification of learning outcomes are also covered by the DS Quality Assurance System, aimed at ensuring high quality of education and research, the system covers the DS students and academic personnel providing scientific supervision (supervisors) and conducting classes (tutors).

3. Qualifications of academic teachers or research staff conducting education at the doctoral school

The qualifications of academic tutors conducting education at the MUT Doctoral School (DS) are an essential element ensuring the high quality of education and research conducted by PhD students and consequently affect the quality of doctoral dissertations and investigations. Possessing extensive specialist knowledge, the ability to effectively pass it on to students and teaching experience, they affect the state of the art in science and innovativeness of education, enabling students to acquire new knowledge, skills and social competences in line with modern trends in science. Academic tutors providing education in the DS often act as supervisors or assistant supervisors, which requires appropriate competences in the field of supporting doctoral students - young scientists in conducting their research and evaluating the results obtained.
The scientific potential of the MUT includes 815 university tutors, including: 96 professors, 160 habilitated doctors and 558 doctors. This group includes two professors Antoni Rogalski and Leszek Jaroszewicz members of the Polish Academy of Sciences, professors: Jerzy Małachowski, Janusz Bogusz and Bogusław Jagusiak, members of the Council of Scientific Excellence, whereas prof. Henryk Fiedorowicz, is a member of the Council of the National Science Centre. It has impact on the number and value of projects carried out at MUT and scientific publications. In the academic year 2024/2025, a total of 259 projects were carried out, including 132 domestic, 24 commissioned by the Ministry of Defence, 56 international and 72 for business entities, and their total value was over PLN 129 million.
The MUT has organized or co-organized over 200 national and international conferences, scientific seminars, congresses and symposia, integrating scientific communities and marking its contribution to the development of science, technology and research promotion. In 2024, the number of scoring publications was 677, including 31 for 200 points (list of the MoS&HE), 146 for 140 points, and 238 for 100. In addition, University has a system for the exchange of scientific information called the WAT KNOWLEDGE BASE, which is a place for recording and disseminating the scientific achievements of employees.
The scientific potential affects not only the offer of supervisors and innovative research topics for the candidates, but also the provision of teaching doctoral students. The appendix presents the scientific business cards of 35 academic tutors (5 each) from 7 DS scientific disciplines.
Classes in the DS carried out in accordance with the curriculum, including module (subjects) common to the first year, and optional subjects included in the Individual Educational Program (IEP). In common module, subjects are carried out by academic tutors and experts from the MUT Department of Science, the Technology Transfer Centre and the Library (subjects: Process of applying for funding for scientific research, Property rights and commercialization of research, and Scientometry and bibliometrics). Subjects from IEP are carried out by academic teachers, mostly university professors.
The selection of academic teachers to conduct classes takes place in two stages. In the first stage, annually for optional subjects of individual scientific disciplines, the deans of the faculties, after analysing the content of the course, indicate the lecturers and the semester of implementation (winter or summer, to avoid duplication of hours). The proposal of the lecturers (for the dean) is prepared by the directors of faculty institutes whose scientific activity corresponds to the subject curriculum. Due to the need to ensure not only a high level of teaching, but also the need to shape the competences of doctoral students, the most experienced academic teachers are chosen. Importantly, due to the flexible education system and few, often one-person groups, it is possible to extend the curriculum content of the subject to include an issue related to the subject of the doctoral dissertation of the doctoral student participating in the classes. Therefore, the lecturer should have extensive knowledge that goes beyond the scope of the subject. The second stage is the actual assignment of the subject leading to the implementation of the course based on the requests for teaching hours prepared and sent by the SDR to individual faculties. In the teachers' demand, he not only determines the number of blocks of classes and the date of their implementation but can also indicate co-instructors – experts in the field of individual issues and those who conduct laboratories or practical exercises in laboratories. The DS creates timetables for the class groups of doctoral students. In the case of IEP subjects, these are often one-person groups.
Between 2019 and 2025, almost 30.000 teaching hours were conducted at the DS, of which over 75% were completed by university professors with a professor title or a doctor habilitated. On average, in the academic year, 144 tutors conducted classes with doctoral students, including 100 professors and habilitated doctors, 37 doctors, and 7 experts, completing 169 subjects for a total of almost 5.000 teaching hours. Professors and habilitated doctors accounted for 73% of lecturers, with over 80% covering the total number of hours.
In the academic year 2024/2025, 6684 hours of classes were conducted by 188 teachers, including 134 professors and habilitated doctors in 217 subjects. Such a structure of qualifications of lecturers and the corresponding hourly delivery ensures a high level of teaching and shaping the competences of doctoral students.
Academic teachers conducting classes in the DS are subject to assessment under the MUT Quality Assurance System for Education and the Quality Assurance System for Education in the DS. This is achieved through quality processes including observation of didactic classes, giving opinions on teachers by students etc. The process of collecting the opinions of participants is carried out through the University Study Service System (USSS) system providing students and doctoral students with full anonymity.
The results of the surveys for each academic teacher, including those teaching in the DS, are forwarded to the proper dean and the DS director. Based on these results, the director/dean may conduct an interview with the lecturer, change the lecturer in the next academic year, or order additional observations.
In addition, considering the results of surveys, information obtained from doctoral students during annual meetings at the beginning of the academic year, individual interviews with doctoral students and the results of graduate surveys, the DS director may request the dean to change the specific teacher. The adopted solutions make it possible to monitor the quality of classes, education conducted in DS and use corrective actions.

4. Quality of the recruitment process

Recruitment to the MUT Doctoral School (DS) is a process aimed at selecting the best candidates, possessing appropriate qualifications and competences, motivation and scientific potential to conduct innovative scientific research. Recruitment to the DS takes place through a competition on the terms set by the MUT Senate, ensuring equal opportunities for all candidates. Transparency, objectivity, and high standards are the features of the DS recruitment process. In accordance with the Law on Higher Education & Science, the Rules of Recruitment are determined annually by the Senate and made available to the public on the website of the Public Information Bulletin of the MUT by the end of February. These rules specify in detail the method of appointing the Recruitment Committee and qualification teams, the schedule of the recruitment procedure, formal criteria, the rules of registration, submission of documents, qualification procedure, awarding ranking points, special recruitment procedure and templates of recruitment documents.
Detailed information on the recruitment procedure for the DS is also made available immediately after the Senate adopts the recruitment rules on the DS website. It contains not only synthetic information about the education offer (disciplines, place limits etc.), rules and course of the recruitment and qualification procedure, but also provides for download templates of documents and instructions for use of the Internet Registration of Candidates (IRC) system. In addition, lists of potential supervisors and research topics are published, which are the basis for the candidate's selection. The DS website is not the only source of information about recruitment, candidates can find information on websites dedicated to Polish doctoral schools, e.g. the website of the Ministry of Science & HE: www.radon.nauka.gov.pl, studiadoktoranckie.inf, as well as in social media (YouTube, Facebook, etc.). In March and June, information meetings for candidates are organized online (the MS Teams communicator). The exact date is announced on the main website of the MUT and DS at least two weeks before the meeting. In addition, the employees of the Dean's Office provide information by phone, e-mail and in person. The DS leaflets are available and distributed, school is also promoted at various types of academic meetings, educational fairs, conferences and symposia. The resolution of the Senate - the Rules of Recruitment is the basis for issuing documents regulating the recruitment procedure, including: the Rector's decision on the appointment of the Recruitment Committee and Qualification Teams; limits of places; recruitment fee; lists of potential supervisors with proposed research topics; information on the rules of recruitment to the "Implementation Doctorate" programme and additional information for foreigners.
The Recruitment Committee and the Qualification Teams are appointed by the Rector's decision based on candidates recommended by the chairs of the councils of scientific disciplines (selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline). In the event of circumstances that may affect impartiality and objectivity in the assessment of candidates, a member of the selection team is subject to exclusion from the assessment of the candidate. At least 7 qualification teams corresponding to the scientific disciplines conducted in the DS are appointed. Since 2020, recruitment to the DS has been conducted exclusively via Internet using the IRC system. Thus, not only all documents required in the recruitment procedure are submitted in electronic form, but also information on the need to complete the documents, the date of the interview, qualification/non-qualification, and the Rector's decision to refuse admission are provided to candidates in electronic form.
The recruitment rules for the academic year 2025/2026 specify that candidates with a master's degree, knowledge of English at the B2 level and will receive a written statement (acceptance) from a potential supervisor can apply for admission to the DS. It is also required that the completed master's degree programme, scientific achievements or other forms of education coincide with the scientific discipline chosen by the candidate. The recruitment procedure is the same for all candidates, regardless of the scientific discipline.
Ranking points are awarded to candidates according to the following criteria: result of completion of master's studies (0-20 points), qualifications and competences to educate in the DS in a selected scientific discipline (0-10 points), scientific achievements (0-30 points), concept of doctoral dissertation (0-10 points), interview (0-40 points). Interviews take place in a stationary form at MUT or online. The interview is conducted by the Qualification Team appropriate for the scientific discipline selected by the candidate. The interview consists of two parts: a presentation by the candidate of the initial concept of the doctoral dissertation and questions from the members of the selection team aimed at checking the candidate's ability to conduct a scientific discussion and the candidate's general knowledge in the field of the selected scientific discipline. The maximum number of points possible to obtain is 110, and the required minimum number is 55, with at least 20 from the interview. The inclusion of a candidate on the list of pre-qualified within the limit of places for a scientific discipline is determined by the order of places on the ranking list, ranked according to the decreasing number of points. Foreigners are recruited on the same terms as other candidates, except that the documents and the interview (online) take place in English. An additional requirement due to the specificity of the military unit is the need to obtain a positive opinion of the candidate issued by the Military Intelligence Service. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the DS However, they have the opportunity to apply for the elements of the recruitment procedure to be adapted to their needs resulting from their disability. The results of the recruitment are published on the DS website. Candidates have access to their results through the IRC system. Every year, several appeals against the Rector's decision to refuse admission to the DS are considered. They mainly concern the possibility of increasing the limit of places, comments on the ranking points awarded, as well as on the course and results of the interview (subjective impressions of the candidate, human factor). The submitted applications are analysed by the Admissions Committee, considering the documents submitted by the candidate, the opinion of the qualification team, and recommends a decision to the Rector.
The rules, as a result of the annual evaluation, changed significantly, the first recruitment took place solely based on the assessment of the candidate's achievements and qualifications (the experience from the faculty recruitment committees was transferred). In subsequent years, an interview was added, and an attempt was made to achieve a certain balance between candidates who have recently graduated from universities and candidates with work experience. Collecting comments on the course of recruitment takes place during the recruitment process. This applies to the Dean's Office employees involved in the recruitment process, candidates, chairs of qualification teams and pre-analysed at the Admissions Committee meeting. In

addition, comments are collected from candidates admitted to the DS at the organizational meeting at the beginning of the academic year and as part of the candidate survey. The process of the Education Quality Assurance System in the DS is used. All comments and suggestions are subject to analysis and, after aggregation, presented at the meeting of the DS Council, where, because of the discussion, changes are possibly recommended to be introduced in the next recruitment. The draft resolution of the Senate establishing the rules of recruitment to the DS is agreed by the other MUT units and the Senate committees. Since 2020, the DS has been recruiting candidates as part of the "Implementation Doctorate" program of the Ministry of Science &HE. This is a special competition procedure (apart from the limits of places specified by the Rector), conducted based on the DS Recruitment Rules and the rules of this programme. Detailed rules, document templates and the recruitment schedule are determined by the Recruitment Committee.
In the years 2019-2025, 656 candidates, including 6 foreign candidates, applied for admission to the DS. The greatest interest was in three scientific disciplines: Safety Science (215 candidates), Information & Communication Technology (123) and Mechanical Engineering (118). Out of all candidates, almost 70% were graduates of the MUT, and over 60% were people who completed master's studies with a very good result. A total of 415 people were admitted, including 4 foreigners. In addition, in addition to the limit under the five editions of the "Implementation Doctorate" programme, 16 people out of 25 candidates were admitted to the DS, and one person under the scholarship programme of the National Agency for Academic Exchange. After seven consecutive recruitments, the principles and the method of recruitment seem to be appropriate in the context of quality and objectivity. The interview has become a key criterion in assessing the candidates' predispositions for education in DS and scientific work.

5. Quality of scientific or artistic supervision and support for conducting scientific activities

Scientific supervision of doctoral students at the MUT Doctoral School (DS) is characterized by a high substantive level and an individual approach to the needs of doctoral students. Supervisors and assistant supervisors actively support doctoral students in developing research competencies, creating the doctoral student's independence and strengthening his responsibility for scientific development.
The method of appointing and changing the supervisor, supervisors and assistant supervisor is specified in detail in the DS Regulations. The supervisor may be a person holding a professor or dr habilitated degrees, employed at the MUT. With the consent of the competent discipline council, the supervisor may be also a person of a foreign university or scientific institution, who has significant achievements in the field of scientific issues related to the doctoral dissertation. An assistant supervisor may be a person with at least with a doctoral degree. Candidates for supervisors are selected annually by the scientific discipline council. To maintain the quality of supervisor care, the councils adopted resolutions that a supervisor may not take care of more than 4-6 doctoral students. Other requirements include the recommended scientific and research position of the supervisor, current publication achievements and conducting research projects. In accordance with the recruitment rules, the lists of potential supervisors with the proposed research topics (annex to the resolutions of the discipline councils) are available to candidates on the website from 1 June of a given year. In addition, candidates can familiarize themselves with their portfolio in the publicly available MUT Knowledge Base (profile of a person, publications, research data, projects, supervisor, cooperation) before choosing a supervisor.
The MUT employs 815 academic teachers, including 96 with the title of 160 with the degree of habilitated doctor and 558 with the degree of doctor. As at the date of the report, 256 DS doctoral students are supervised by 122 supervisors and 117 assistant. Among the supervisors there are 40 professors, including one from abroad and 82 hab. doctors. Statistically, one supervisor takes care of two students. In addition, doctoral students pursuing education under the "Implementation Doctorate" programme are covered by additional scientific supervision provided by supervisors appointed by the institution employing the doctoral student. The method of selecting potential supervisor is discussed annually at the meeting of the DS Council. The role of the supervisor is primarily scientific supervision carried out in a systematic manner through regular consultations and ongoing monitoring of the implementation of the Individual Research Plan (IRP). Supervisors with experience and scientific achievements provide doctoral students with effective methodological support in the formulation of research problems, selection of methods and analysis of results. Scientific supervision is therefore conducive to the development of research independence of doctoral students and their publication activity in accordance with the principles of scientific research ethics, with care for the reliability and quality of research workshops. Supervisors, demonstrating high availability and responsiveness, enable a quick response to the needs of doctoral students. In addition, the supervisor's experience is used in the creation of the Individual Education Program (IEP), aimed at expanding or acquiring the knowledge, skills and competencies necessary for the implementation of the IRP. The fundamental idea of the DS is to create a new relationship between the supervisor and the doctoral student: master-student instead of teacher-student. In this way, "professorial schools" are created, in which the supervisor – an outstanding scientist – the manager of research projects, engages doctoral students in their implementation, and at the same time supports them financially. Cooperation between the supervisor and the doctoral student is formally sanctioned in the curriculum by the module entitled Research Area Analysis (30 hours, first semester) and scientific supervision (15 hours each semester).
In the event of a conflict between the supervisor and the doctoral student, the manner and procedure of proceeding (mediation) are specified in the DS Regulations. So far, we have had only one case of conflict, and the problem was solved with the involvement of the director and the chair. After appointing a new supervisor, the doctoral student successfully continues her education (currently the third year). The quality of scientific care is assessed not only by the results of progress in the implementation of IRP, the result of the mid-term evaluation, the scientific activity of doctoral students, but also by the processes of the System ensures the quality of education in the DS – surveying students after mid-term evaluation and DS graduates. The conclusions of the evaluation are used to improve the process of scientific supervision, the quality of education and the improvement of procedures supporting doctoral students. The strength of the DS is the semester-long doctoral seminars, in which, in addition to doctoral students, supervisors are attended by the chairmen of the disciplinary councils or their deputies. A novelty is the introduction of a doctoral seminar after the 7th semester in front of the scientific discipline council, which is a kind of pass to finalize the dissertation.
Support for doctoral students in the process of education is aimed at creating favourable conditions for research, preparing a dissertation and acquiring knowledge, developing skills necessary for further academic or professional careers in accordance with the principle: Doctoral student in the center of the DS attention. The DS also provides a wide range of institutional support. PhD students have access to specialist trainings, workshops and seminars developing both research competences and soft skills (writing scientific articles, obtaining grants, presenting research results). The support also includes assistance in planning a career path, creating the IEP and IRP, as well as and preparing scientific publications. An important element is access to research infrastructure and library resources, which enables research to be conducted at a high level. Doctoral students can also count on administrative assistance in formal matters related to education and scientific activity. The DS promotes an environment conducive to integration of the PhD students representing different disciplines, organized seminars, meetings and scientific events support the establishment of research cooperation.
To sum up, the quality of scientific supervision and support for doctoral students is high, comprehensive and focused on the development of independent researchers capable of conducting innovative projects at the national and international level.

6. Integrity of the mid-term evaluation process

Mid-term evaluation of a doctoral student is a process carried out in the middle of the period of education at the Doctoral School (DS) aimed at analysing and assessing the progress of the doctoral student in the implementation of the Individual Research Plan (IRP), and thus the preparation of the doctoral dissertation and scientific activity. It is also focused to identify potential problems that may affect the next stages of the doctoral dissertation and to ensure high quality education.
The condition for a doctoral student to take the mid-term evaluation is to obtain a credit for the doctoral seminar and the semester report in the third semester of education. Until 2024, the mid-term evaluation took place in June of a given year, but at the request of doctoral students and after consultations with the Students' Government, it was moved to September 2025.
The method of conducting the mid-term evaluation is specified in the Regulations and the normative documents issued on the basis thereof, i.e. the Rector's determination of the criteria for the mid-term evaluation; decision on the appointment of the Committee for the Mid-term Evaluation; the decision of the director on establishing the schedule for the evaluation and determining the template of the mid-term report, opinion of the supervisor. The evaluation is carried out by a three-person Commission appointed by the Rector for each scientific discipline and covers the period from the commencement of the education to the date of submission of the mid-term report. It is composed of the expert holding an academic title in the specific scientific discipline, including at least one person from outside the MUT. Experts for the committee are recommended by the chairmen of the councils of scientific disciplines. The number of committees corresponds to the number of disciplines conducted in the DS. The Committee determines the result of the mid-term evaluation of a student on the basis of the criteria: timeliness of the implementation of the stages of preparation of the dissertation specified in the IRP; compliance of the completed dissertation preparation with those planned in IRP; compliance of the degree of implementation of the planned stages; the doctoral student's scientific activity - compliance and degree of implementation of planned projects (conferences, internships, publications); the level of advancement of the preparation of the doctoral dissertation and the assessment of the deadline for its submission. When evaluating individual criteria, the members of the committee may additionally take into account: the scientific achievements; participation in projects, grants, programmes, planned scientific activity included in IRP in semesters above IV, consent of the director to postpone the date of the mid-term evaluation delays in the implementation of IRP caused by random factors. The members of the committee determine the result in individual criteria based on the analysis and evaluation of documents related to the implementation of IRP and the preparation of the dissertation (IRP, interim report, supervisor's opinion), as well as the self-presentation and evaluation interview on issues related to the implementation of IRP. Presentation of the student (max. 20.min.) and the evaluation interview (approx. 20 minutes) takes place in front of the committee. Sessions are organized by the DS and conducted by the director (without voting rights). Neither the supervisor nor any other person may participate in the session. However, at the request of the doctoral student, a representative of the Students' Government may participate in the session as an observer (so far there has been no such request). Each member of the committee evaluates the doctoral student within the framework of individual criteria, determining the result as positive or negative. The result of a criterion is positive if at least 2 members of the committee for this criterion have determined a positive result. The condition for a positive mid-term evaluation of a doctoral student is to obtain positive final results from all criteria. Immediately after receiving the protocol from the committee, the Director makes available on the website information on the result of the student's assessment along with its justification. A student has the right to appeal to the director against the result of the mid-term evaluation - so far there has been no appeal.
With a view to properly preparing doctoral students for mid-term evaluation, a few months before the evaluation, DS organizes a dedicated training during which the principles and course of evaluation are discussed, as well as templates of documents prepared by doctoral students. The DS also organises an information meeting for the members of the committee, where issues related to the mid-term evaluation process are discussed, including the timetable for the implementation, the rules and criteria for the evaluation, the preparation of the results and the justification, the templates of the evaluation sheet and the protocol. After the completion of the work of the committee, a meeting with the SDR management is organized to discuss the organization of the evaluation process and the comments and suggestions of the committee, which are also discussed at the meeting of the SDR Council. The course of the mid-term evaluation is also assessed as part of the process of the System for Ensuring the Quality of Education in SDR – a survey of doctoral students after the mid-term evaluation.
In the years 2021-2024, 200 doctoral students, including 1 foreigner and 11 doctoral students of the "Implementation Doctorate" program, were subject to mid-term evaluation. A positive grade was obtained by 194 doctoral students (97%) and a negative evaluation by 6 doctoral students (3%) in the following disciplines: materials engineering (1), mechanical engineering (2), chemical sciences (2), safety sciences (1). In addition, in the second half of September 2025, a mid-term evaluation of 52 doctoral students was carried out, all of whom received positive grades.
The level of negative grades of 3% is an important message about the mid-term evaluation and is the third element of the evaluation of the student's progress after two doctoral seminars in semesters I and III.
The added value of the mid-term evaluation is the recommendations of the committee regarding further research of the student, transmitted directly to the students, especially since they are also formulated by experts from outside the MUT.
In our opinion, the adopted procedure of mid-term evaluation works well and is a very important stage in the evaluation of a doctoral student's progress (this was lacking in doctoral studies). It is also a verifier and evaluation of cooperation between the supervisor and the doctoral student, because in the case of a negative assessment, it also has consequences for the supervisor.

7. Internationalization

The internationalization of the MUT Doctoral School (DS) is a process involving the systematic inclusion of international elements in the education and research activities of doctoral students. Its aim is to improve the quality of research, increase the attractiveness of the academic community and doctoral students in the international research area. An important area is mobility of students and academic tutors – supervisors, lecturers conducting classes in the DS for foreign research trips, internships, consultations, conferences, symposia, as well as tutorial by foreign researchers, which enrich the academic community with new perspectives and experiences. Mobility is conducive to the exchange of experiences, the development of research competences and the establishment of new contacts. Another aspect is international cooperation in projects, programs, branches within international, interdisciplinary research teams and dissemination of research results. This affects the development of language and intercultural competences of doctoral students, allows them to participate in innovative research and learn about various methodologies and standards of scientific work, the possibilities of using open science in accordance with the principles of ethics. It also increases the attractiveness of the DS and strengthens its visibility in the scientific community by building the image of DS as an open and attractive place for candidates from all over the world. Currently, 4 foreigners are educated in the DS, including one under the program of the National Agency for Academic Exchange (2 from India, 1 from Egypt and 1 from Vietnam). All foreign students are exempt from education tuition, are given the doctoral scholarships, and are also exempt from accommodation fees in the Assistant's Dormitory for the first six months of education. The DS employees provide support in applying for the consent of the Military Counterintelligence Service (MCS), a visa at the consulate, and upon arrival in the country for a PESEL number, health insurance, a bank account, and a temporary residence card. Classes, meetings and documentation of foreign doctoral students are conducted in English. In the recruitment limits, four places are reserved for foreigners. This limit results not from the potential of the MUT, but from its specificity. MUT as a military unit is subject to different regulations than civilian universities, for a foreigner, residence and education permit at MUT is issued by the MCS, which significantly limits the number of places for foreigners. Information on recruitment and education is available on the DS website, in the English-language newsletter on social media, at educational fairs and on the events organized by MUT. The promotion on the international forum is also provided by the Department of Promotion and International Cooperation.

The PhD students have full access to "international exchange" and take part in foreign conferences, research internships, and undergo part of their education at foreign scientific institutions and universities. Although DS does not have funds to finance this type of activity, funding is carried out as part of University Research Grant projects (financial resources for the development of research potential) carried out in academic faculties (in 2025, 87 URG projects were implemented). For example, in 2024/25, monthly research internships were completed by: Szymon Saternus, Maciej Spychała - Aalborg University, Denmark; Jan Mikocki, - Jet Propulsion Laboratory, CalTech, USA; Kamil Chudy - Space Orbital Mechanics course, Stanford University, USA. students take part in an exchange abroad as part of the Erasmus+ Student Mobility for Traineeships programme. Recently, the MUT has signed bilateral agreements for the exchange of students, doctoral students and lecturers with 97 European universities. In the academic year 2024/2025, 99 students and doctoral students and 37 employees of the University were on semester exchanges, internships, trainings and teaching mobility. There were also 712 trips abroad to 42 countries. The PhD students participate in international conferences organized in country and abroad. Most publications are published in renowned English-language journals.

The university cooperates with foreign institutions and engages doctoral students in the implementation of international projects. In the academic year 2024/25, the university implemented 56 international projects with an amount of over PLN 18 million, which accounted for 14% of the financial budget of the MUT. The most important projects are:

European Union's Horizon 2020: Laserlab-Europe, the Integrated Initiative of European Laser Research Infrastructures; VIGIMARE - Vigilant Maritime Surveillance of Critical Submarine Infrastructure; COURAGEOUS2 - Building a common understanding of the effectiveness of counter-UAS solutions.

European Space Agency (ESA): Human & Robotic Exploration, Project: Human Gut Microbiota, (project concerns medical research of astronauts in Earth orbit and is carried out as part of the Axiom-4 mission on the International Space Station).

European Defence Fund (EDF): Tactical Advanced Laser Optical System, TALOS I - WP2; Coherent Beam combining optics; TALOS II –WP4.2 - High power distortion bench, WP5.2. Measurements of low absorption and low distortion plates. Technologies for High-Power Lasers, Vulnerability Analysis, Development of Laser Weapon Use Scenarios, Operational Analysis.

European Defence Agency (EDA): Biological Effects of Radiofrequency Electromagnetic Fi, QLAMPS - Quantum Laser-based Multi-parametric Portable elds (RFBIO); QLAMPS - Quantum Laser-based Multi-parametric Portable Sensors; PYTHIA – Predictive methodology for Technology Intelligence Analysis.

It is worth emphasizing that the specificity and tasks of the MUT as a military university, the Academy participates in the implementation of projects and programs coordinated by NATO and delegates its employees to represent the Polish Armed Forces in NATO scientific and technical organizations and agencies, such as: NATO Communication and Information Agency, Science and Technology Organization, NATO Standardisation Office, NATO Science for Peace and Security Program, Open Skies Treaty. In NATO scientific panels: ATO Modelling and Simulation Group, Studies, Analysis and Systems, Systems Concepts and Integration, Sensors and Electronics Technology, Information Systems Technology, Applied Vehicle Technology, MUT employees are not only permanent national experts, but also carry out joint scientific projects within Research Technology Groups.

To sum up, the number of foreign doctoral students in the DS is not satisfactory - 4 doctoral students (however 4 places available, since 2021 annually), in our opinion, the main reasons are: the status of the university as a military unit and, as consequence, restrictions, the required approvals of the MCS. What is more, recent changes in the visa policy (Polish and the EU) cause uncertainty regarding the optimal directions of internationalization of the doctoral student community, it concerns candidates from countries outside the EU. On the other hand, the strengths of the DS are bilingual functioning, the school provides good conditions for the development of competences to work in an international environment, experience in

educating doctoral students, projects and cooperation.
Undoubtedly, internationalization strengthens the image of DS as a modern, open and capable of conducting research at the highest level. This not only increases visibility in the academic community, but above all increases the competences of doctoral students, preparing them for scientific activity in the national and international research environment.

8. Effectiveness of doctoral education

Percentage of individuals who obtained a doctoral degree	Doctoral students who applied for initiation of proceedings for the award of a doctoral degree	Doctoral students who were awarded a doctoral degree	Doctoral students who were denied the award of a doctoral degree
in the number of doctoral students who completed their education at the doctoral school during the evaluation period	86 %	68 %	0 %
in the total number of doctoral students who completed their education at the doctoral school	62 %	49 %	0 %

The effectiveness and efficiency of education of doctoral students at the MUT Doctoral School (DS) is a key indicator of the quality of education and preparation of doctoral students to obtain a doctoral degree.
As at the date of preparation of this report, 44 PhD students graduated (2019 – 19 graduates, 2020 – 21 and 2021 – 4), of whom 30 people received the doctoral degree. Thus, the effectiveness of education was 68%, but this value is not final, because the remaining 14 students are under way in the procedure for awarding the doctoral degree. Three doctoral students who did not submit their doctoral dissertation within the deadline specified in the Individual Research Plan (IRP), which considers the statutory extension period, were deleted from the list of the doctoral students.
The graduates during their education in the DS, presented very high scientific activity, published: 331 papers, including 13 for 200 points (list of MS&HE), 62 for 140, 64 for 100 points. They have participated in 167 conferences, including 67 foreign ones, and participated in the organization of 17 conferences, including 14 international. They completed 22 scientific internships and participated in 107 projects. They also received 40 awards and distinctions.
The assessment of the quality of education is carried out also by graduates as part of the process of the Quality Assurance System. Out of 44 graduates, 26 people (59%) completed the surveys, and the average score (of 4 criteria) was 9.4 points (scale from 0 to 10). The graduates rated: the process of education – 9.32 points, the IRP (in general) – 9.32 points, the quality of scientific care – 9.47 points, and the organization and administrative support – 9.51 points.
Monitoring of the professional careers graduates is carried out also by the National System for Monitoring University Graduates, which contains information on the professional activity and career development after doctorate.

1. automation, electronics, electrical engineering and space technologies

Achievement Description

1. **Estera PAWLIKOWSKA** (2021-2025), ***PhD thesis:*** Construction and research of fibre optic sensors enhancing quantum channel protection of a quantum key distribution system. ***Abstract:*** The paper puts forward the thesis that in QKD systems it is possible to detect a violation of the integrity of the quantum channel by detecting disturbances resulting from an attempt to introduce eavesdropping. The aim of the work was to develop a sensor system that allows the detection of disturbances in the quantum channel, and its presence does not affect the level of QBER quantum errors in the QKD system. The subject of the paper is an analysis of the possibility of implementing additional hardware security in a two-way QKD play-&-play fibre optic system. The purpose of the sensors was to detect dynamic changes in the state of polarization in the quantum channel, resulting from the manipulation of the optical fibre. The presented solutions include a group of sensors sensitive to changes in the polarity state: a four-channel Stokes FCSP polarimeter and PBS, operating in TCP and POL configurations, tested in the QKD laboratory system. In the SDKK system, the operation of a TCP sensor with single-photon detectors and a sensor operating on a second optical band of 1310 nm was investigated. To isolate slow-changing fluctuations resulting from the influence of external factors, alarm indicators have been proposed to eliminate the signal trend. Based on the results, the ability of the sensors to detect disturbances: touching, bending and inserting the clip-on coupler, which accompany the installation of eavesdropping on the optical fibre, was determined. The QBER analysis confirmed that the implementation of sensors does not increase quantum errors in the QKD system and enables the detection of perturbations that are not detected based on OBER. The proposed systems can be implemented in plug-and-play QKD fibre optic systems. They make it possible to detect fiber manipulation when attempting to introduce eavesdropping and increase the security of QKD, making it more difficult to carry out an attack on a quantum channel. ***Scientific activity:*** Pawlikowska E., et al. Testing of Four Channel Stokes Polarimeter performance for intrusion detection in QKD systems. Opto-Electronics Review, **100;** Pawlikowska E., et al. Implementing a polarization- sensitive sensor in a plug-and-play QKD system, Opto-Electronics Review, **100. P*rojects:*** SZAFIR/01/A/013/01 Optical technologies of quantum cryptology for data protection in ICT networks (2021-2024); SZAFIR/01/A/023/01 MIKOK (2021-present).
2. **Kacper KARCZ** (2020–2025) ***PhD thesis topic***: Composite structures with high efficiency of attenuation of high-

energy pulses of electromagnetic radiation HPM. ***Abstract:*** The presented dissertation addresses the problem of protection of electronic systems against the influence of high-power microwave pulses (HPM) through the development of composite structural materials with high electromagnetic shielding efficiency. In the context of increasing dependence on electronic systems and the growing threat from directed energy weapons, the work focuses on the design, characterization and validation of composite structures enriched with carbon and magnetic nanostructures. The research combines measurement and analysis of material properties with electromagnetic modeling and experimental validation in laboratory and field conditions. A multi-stage methodology was carried out, including the synthesis of over 160 composite samples based on various polymer matrices (PVDF, PDMS, PMMA, epoxy resins) and fillers (reduced graphene oxide, carbonyl iron, ferrites), followed by their electromagnetic characterization using a vector analyzer, spectroscopic methods and scanning electron microscopy. The effectiveness of the developed materials was evaluated in terms of shielding against HPM pulses in the GHz frequency range. Field tests have confirmed shielding efficiency at a level exceeding 90dB for different exposure directions, which corresponds to a reduction in the electromagnetic field intensity inside the structure by more than five orders of magnitude. Numerical simulations confirmed the experimental results and enabled the optimization of the design.
Scientific activity: **7 publications,** the most important: Karcz K., et al. New Electromagnetic Threat Protection Systems, Problems of Mechatronics, 2023, ***70;*** Karcz K., et al. Protecting ports from modern threats: the role of electromagnetic weapons in countering unmanned aerial vehicles. Yearbook of Maritime Safety, 2024, ***70;*** Karcz K., et al. Directed Energy Weapons: Dissecting Effects and Potential Use. IRS Symposium, ***80;*** Karcz K., et al. Electromagnetic radiation attenuation materials. Safety Engineering, ***70. Projects:*** Methods and methods of protection and defense against HPM radiation (008-1-3/1/PS/2014) (2021); European Hypersonic Oefence Interceptor (2022-2024); SZAFIR 008-R/02/8/031 Autonomous Distributed Aerial Vehicle Combat System (2023-2024); ***Patent:*** Screen container equipped with grommet No. P.245790. ***Awards:*** First prize for a poster at the IX Congress of Metrology 2023.
3. **Michał NOWAK (.....), *Dissertation topic:*** Fabrication and reversible modification of optical properties of plasmonic nanostructures. ***Scope****:* The subject matter of the research concerns metallic-dielectric structures and the phase change material vanadium dioxide (V02). Thanks to the dependence of the refractive index of the V02 layer on temperature, it is possible to actively control the optical properties of the structure. An original aspect of the research is: the influence of the parameters of production and modification of aluminium structures and V02 layers on their optical properties. Such structures can be used, m.in, as optical modulators, for the production of aesthetic elements or in document security. Structural color, which is a good substitute for chemical dyes.
Scientific activity: 11 publications, the most important: Nowak M., et al. Laser Control of Specular and Diffuse Reflectance of Thin Aluminum Film-Isolator- Metal Structures for Anti-Counterfeiting and Plasmonic Color Applications. Coatings, **100;** Nowak M., et al. Wide-Range Angle-Sensitive Plasmonic Color Printing on Lossy Resonator Substrates. Advanced Optical Materials, **140;** Nowak M., at al. Strong angular and spectral Narrowing of electroluminescence in an integrated Tamm-plasmon-driven halide perovskite LED. Nature Communications, **200.**
4. **Martyna WARDZIŃSKA** (2021 -...), ***Dissertation topic:*** Studies of optical elements for the vacuum ultraviolet range for advanced space applications, in particular the GLOWS photometer of the NASA IMAP space mission. ***Subject:*** The doctoral dissertation concerns a laser-vacuum source generating radiation in the vacuum ultraviolet range. The source has been optimized and used for detailed measurements of optical filter transmission and reflectance coefficients of blackened samples for the CBK PAN to the GLOWS photometer of the NASA IMAP space mission. In metrology, VUV measurements often require a unique infrastructure. The measurements made in the work confirm the metrological potential of the source, opening the possibility of performing measurements of optical elements for operation in space conditions. Familiarizing the scientific world with the possibility of performing such measurements on a compact laboratory source is innovative and has scientific aspects.
Scientific activity: 4 publications, the most important: Wardzińska M., et al. Reflectance properties of the Acktar Magie Black™ coating for the radiation near the Lyman-a line of hydrogen: measurements and phenomenological model of the BRDF. Journal of Astronomical Telescopes, Instruments & Systems, **140;** Wardzińska M., et al. Characteristics of vacuum ultraviolet emission from a laser plasma radiation source based on a gas puff target, **100. *Projects:*** LASERLAB-EUROPE - Integrated Initiative of European Laser Research Infrastructures PRUE/31-417/2019/WAT; PolFEL - Polish Free Electron Laser FS/32-432/2018/WAT; ***Internship:*** Replacement of employees of the Laserlab-Europe consortium (FERMI free-electron laser), Trieste (2023).
5. **Mateusz CZERWIŃSKI** (2000-...)***, Dissertation topic:*** Modifications of the morphology and crystal structure of anodic titanium dioxide in order to use it as a substrate for surface-enhanced Raman spectroscopy. ***Scope of research:*** As part of preliminary research, we determined that ATO (Anodic Titanium Oxide) may be an interesting base for SERS substrates due to its developed surface, semiconductor properties, low preparation costs and great freedom in terms of morphology modification possibilities. Substrates based on doped ATO (Mn, V, Mo, W ions) with the morphology of nanopores and nanotubes coated with a nanometre layer of adsorption oxide were prepared and their detailed analysis was performed. They were compared with commercially available substrates: SERSitive, Horiba, Silmeco and Ocean Insight.
Scientific activity: 9 publications, *the most important:* Czerwiński M. et al. Understanding the influence of electrolyte aging in electrochemical anodization of titanium, Advances in Colloid and Interface Science, Elsevier, 2022, **200;** Czerwiński M. et al. Anodizing of iron-based alloys: fundamentals, recent progress, and applications, Reports on Progress in Physics, IOP Publishing, 2025, **200;** Czerwiński M. et al. Morphological and semiconductive properties of the anodic oxide layers made on Fe3Al alloy by anodizing in tartaric-sulfuric acid mixture, Scientific Reports, Nature, 2023, **140. *Projects:*** Project LIDER/50/0199/L-9/17/NCBR/2018 - main contractor. Research grant OPUS UMO-2019/35/8/STS/04215 and GB Sonata UMO- 15/17/D/ST8/02432.

2. security studies

Achievement Description

1. **Paweł JAŚKIEWICZ** (2021-2025), ***PhD thesis topic:*** Recruitment model for defence attaché positions in the context of military security. ***Abstract:*** Scientific research and its results contributed to the development of a concept for improving the model of the process of planning the recruitment of professional soldiers to serve in attachés - in the field of the use of personnel resources of the MoD. The main argument was the observed trends in the functioning of the institution of defence attachés, whose role, according to the Author, is crucial in the process of building the military security. In addition, observation of the recruitment process for the service positions allows us to conclude that this process is extremely long. As a result, the postulates became a prerequisite for undertaking research on the issue of improving the process of planning the recruitment of defence attachés. The methodological assumptions of the dissertation present the prerequisites for undertaking the research, the main research problem and the main goal of research. The main research hypothesis and detailed hypotheses, the subject and subject of the research, as well as the area and period of the research are presented. Source materials, theoretical and empirical methods, as well as research techniques and tools are indicated. The dissertation formulates the main research problem: how will the new model of recruitment of officers for the positions of defence attaché in the face of current threats improve the military security of the Republic of Poland? For this research problem, the main goal of the work is presented - the development of an original model of planning the recruitment of soldiers for the positions of defence attachés. For the research problem formulated in this way and for the dissertation, as well as because of the state of knowledge, literature analysis and forecasted changes, the main research hypothesis of the dissertation was adopted: it is assumed that the author's model of recruitment planning for the cited service positions will strengthen military security. The dissertation contains original solutions in the field of improving the process of planning the recruitment of attachés. The developed model assumes the use of a prepared database, which will contain former defence attachés. The corps of the diplomatic service would provide for the use of personnel potential, which has already undergone the recruitment process. The new solution will shorten the process by not participating in it by people who have already completed this process and held positions in international structures.
Scientific activity: **15 publications,** the most important: Jaśkiewicz P., et al. The forecasting of Dangerous Goods Transport by Rail in Poland in Terms of Environmental Security. ERS Journal, **100;** Jaśkiewicz P., et al. Multidimensional Comparative Analysis of the House Price Index in Europe between 2021-2022 in the Aspect of Economic Security. Journal S&SI, **100;** Jaśkiewicz P., et al. The Forecasting of Salaries in European Countries in Terms of Economic Security. Journal S&SI, **100;** Jaśkiewicz P., et al. The Impact of the Covid-19 Pandemic and the War Between Russia and Ukraine on Electricity Prices in 2022. Journal S&SI, **100**.
2. **Marek PARDYAK** (2019–2023), ***Dissertation topic***: Faces of terrorism and methods of studying its psychosocial and organizational determinants. ***Abstract:*** The subject matter of the dissertation includes the analysis of the phenomenon of terrorism in relation to the activities of non-state actors in various regions of the world. The achieved cognitive and utilitarian goals included designing an innovative tool for analysing the degree of radicalization and an experiment that would enable the identification of the behavioral "*momentum"* of terrorism. During the research process, over 1000 different scientific sources were analysed, supported by participation in 45 conferences and workshops (including 37 outside the Republic of Poland), and 19 scientific consultations with international experts were conducted.
Scientific activity: **5 publications**, including: Pardyak M., et al. Bridges instead of walls. 10 years of Security Sciences. Avalon, 2021, **70;** Pardyak M., The role of perception in countering violent extremism, Journal of Central and Eastern European African Studies, 2021, **70**; Pardyak M., 100 directions of research on terrorism and violent extremism. 10 years of SS, 2021, **70.** ***Research Internship:*** Georgetown University, Terrorism and counterterrorism (2021); Asser Institute, Advanced programme on terrorism, countering terrorism and the rule of law (2021); University of Queensland, Global media, war and technology (2021); Polish Embassy in Cairo (2023). ***Projects:*** Conflict Research Consortium for Africa (2023); European Research Community on Radicalisation (2023); Promoting collaborative policies of inclusion relating to children of Far Right and Islamist parents in Europe (2023).
3. **Dominik PIĘKOŚ** (2021-2025), ***Dissertation topic:*** The role of military transport by rail in ensuring the military security of the Republic of Poland**.** ***Abstract:*** The doctoral dissertation was aimed at identifying and evaluating the functioning of rail transport. The functioning of rail transport was analysed based on theoretical and empirical research. Theoretical research methods were used to solve the research problems: analysis, synthesis, comparison, abstraction, generalization and inference. In addition, in order to obtain the practical dimension of the dissertation, empirical methods were used: desk research, survey study, individual interview with experts, participant observation, case study and modelling. It was stated that the role of rail transport in the process of meeting the transport needs of the Polish Armed Forces is very large. Ensuring the military security of Poland is not possible without ensuring the logistical security, and thus without the proper functioning of military transport by rail. The needs for the use of rail transport by the PAF are very large and are systematically growing. The needs in terms of railway infrastructure, means of transport and properly trained staff are particularly important. In its current form, rail transport does not meet all the expectations of PAF. Theoretical and empirical research made it possible to identify problems, possibilities of their solution, and allowed for the development of conclusions and directions of improvement in the following areas means of transport, personnel, support for the transport of troops, communication, use of modern technologies, management and railway infrastructure. The developed research results are the basis for further scientific work, and the continuation of research is necessary due to dynamic changes in the structure and deployment of military units, or in connection with the PAF modernization. ***Scientific activity*****: 11 publications,** the most important: Piękoś D., et al. Assessment of the Logistics Service Provider PKP Cargo Using Indicator Analysis. Military Logistics Systems, **70;** Piękoś D., et al. Expansion of Logistics Infrastructure In the Oil Sector as a Form of Improving Poland's Energy Security. Journal of Finance and Law. **70;** Piękoś D., et al. Economic and legal aspects of using rail transport for the carriage of dangerous goods. Journal of F&L, **70;** Piękoś D., et al. Personal data protection as an element of the right io privacy. Jof F&L, **70.**
4. **Aneta PAJKA** (2023-...), ***Dissertation topic:*** Development of security sciences using open science resources in Polish military universities. ***Subject of research:*** the basic unit of analysis is the processes occurring during the use of open

science resources in Polish military universities and their importance in the development of security sciences. The creative process will allow for deepening knowledge regarding the development of the discipline of security sciences in the context of open science in military universities. Referring to the discipline of security sciences, research will be a contribution to science, the fundamental element of which is research data, and its value is significantly increased thanks to open access. The research will help in the identification and evaluation of open science resources at military universities that have research data generated thanks to public funding, their acquisition, use and sharing, which would be of significant importance in order to indicate the directions of activities for the scientific community and stakeholders, which is important for the development of the so-called citizen science, including security sciences. Considering the state of security science, the sine qua non condition for ensuring its development is, m.in, the organization of open access to scientific resources in academy through the introduction of institutional policies of open access to scientific publications and research data. Open science, including the opening of research data, is one of the priorities listed in the National Scientific Policy in the context of improving the quality of research, with particular emphasis on the need for Polish scientists to publish results in the global science cycle. Open science infrastructure, including a uniform publication platform of military universities gathering scientific research, is necessary and indispensable in the development of security sciences.
Scientific activity: **4 publications**: Pajka A., et al. Military Logistics as a research field of management and quality sciences. Logistics Systems, **100;** Pajka A., et al. Crisis management as a research province of security science. Annals of Social Sciences, **70;** Pajka A., et al. Cognitive warfare as a new dimension of multidomain operations – mapping and profiling the research area using bibliometric methods. Journal of Modern Science, **100.**

3. chemical sciences

Achievement Description

1. **Sylwia GŁOWNIAK** (2019-2024), ***PhD thesis topic:*** Investigation of physicochemical properties of porous materials obtained by mechanochemical method. ***Abstract:*** A dissertation devoted to the study of physicochemical properties of activated carbons, graphene materials, metal oxides, metal-carbon oxide composites and metal-organic structures obtained by mechanochemical method. The theoretical part describes mechanochemical methods of obtaining porous materials and presents the characteristics of selected groups of porous materials. The adsorption properties of materials against carbon dioxide and hydrogen were reviewed. In the experimental part, the objectives of the work, synthesis procedures and physicochemical properties of the studied porous materials were presented, the morphology of the materials was visualized using scanning electron microscopy and transmission electron microscopy. Structural characterization was made on the basis of low-temperature isotherms of nitrogen adsorption and X-ray diffraction, and the adsorption capacities of the obtained materials in relation to carbon dioxide and hydrogen were determined. During the course of the work, highly porous activated carbons with a specific surface area of over 3000 m2/g, porous graphene material by mechanically increasing the distance between layers in graphite, porous aluminium oxides with preserved phase at high temperatures, and ball grinding was used for the first time for the synthesis of MOF-303. Ball grinding-assisted synthesis of metal-organic structures has been shown to contribute to higher porosity compared to analogous materials obtained by solution synthesis methods.
Scientific activity: **10 publications,** the most important: Głowniak S., et al. Mechanochemical synthesis of highly porous materials, Materials Horizons, 2020, **200;** Głowniak S., et al. Mechanochemistry: Toward green synthesis of metal-organic frameworks, Materials Today, 2021, **200;** Głowniak S., et al. Highly porous carbons synthesized from tannic acid via a combined mechanochemical salt-ternplating and mild activation strategy, Molecules, 2021, **140;** Głowniak S., et al. Advances in microwave synthesis of porous materials, Advanced Materials, 2021, **200;** Głowniak S., et al. Recent developmenłs in sonochemical synthesis of nanoporous materials, Molecules, 2023, **140;** Głowniak S., et al. Ordered mesoporous carbons with well-dispersed nickel or platinum nanoparticies for room temperature hydrogen adsorption, Molecules, 2023, **140.** ***Awards*****:** scholarship of the MUT Rector for scientific publications.
1. **Karol ZALEWSKI** (2019-2024), ***PhD thesis topic:*** Explosive compositions with chemically cured polymer binders — modification of interfacial interactions and property investigation. ***Abstract:*** The main aim of the study was to obtain and determine the explosive properties of PBX compositions, whose interfacial interactions were modified by the addition of a binding compound. In the literature part of the paper, an analysis of the role of individual components of an explosive composition with a chemically cured polymer binder was carried out, along with examples of chemical compounds used. The state of knowledge regarding the composition with polybutadiene and polysiloxane binder is presented. In addition, the purpose of the use of binding compounds and the mechanism of their action at the interface of phases are described, as well as the methods used to assess their effectiveness are presented. The research part of the work began with the optimization of the curing process of polymer binders. The conclusions from the work were then used to investigate the effect of the addition of binding compounds on curing. Studies of binding compounds have been extended to include attempts to assess the ability to modify interfacial interactions using FTIR ATR. In the following part, attempts to implement commercially available polysiloxanes in various types of explosive compositions are described, optimization of the composition of the mixture with a binder based on HTPB supplemented by theoretical calculations in the CHEETAH program is described. The research was an introduction to large-scale laboratory tests, the aim of which was to produce and characterize selected explosive compositions, including a composition with ductile NTO, which would meet the requirements for low-sensitivity explosives.
Scientific activity: **5 publications,** the most important: Zalewski K., et al. A Review of Polysiloxanes in Terms of Their Application in Explosives, Polymers, 2021. **100;** Zalewski K., et al. A new insight into the energetic co-agglomerate structures of attractive nitramines, Chemical Engineering Journal, 2002. **200;** Zalewski K., et al. Rheokinetic studies on the curing process of energetic systems containing RDX, HTPB with high content of 1, 2-vinyl groups and hydantoin-based

bonding agent, Polymer Testing, 2022. **100.**
Projects: Fuel for a hybrid nitric oxide rocket engine for the experimental MUTANT rocket, 2020; Development of new rocket fuel depots based on ammonium chlorate, 2022; Porous carbon materials with mono nuclear coordination centers of the Fe-N4 type; Project "Swarm" 2022-2024. ***Awards*****:** 1st place in the competition for the Kazimierz Siemienowicz Award XIV International Armaments Conference, 2022.
1. **Marcin GERLICH** (2020-2025), ***PhD thesis topic:*** Investigation of the combustion process of gasless retardant mixtures used in explosive detonators (implementation doctorate). ***Abstract:*** The dissertation concerns the development and application of gas-free pyrotechnic mixtures in explosive detonator delaying systems. Traditional mixtures based on gas products have limited stability and low timing accuracy. The solution is gas-free mixtures, in which reactions take place at the boundary of solid phases, which eliminates the effect of accelerating combustion and increases precision. The aim of the study was to analyze the combustion properties of these mixtures, assess their usefulness in delay igniters and verify their implementation in NITROERG S.A. The research included literature and experiments: combustion rate measurements, thermal, calorimetric, X-ray and microscopic analyses, as well as friction and impact sensitivity tests. The results showed that gaseous mixtures burn stably, their parameters depend on density, grain size and composition. Formulations were developed to obtain the 25, 100, 200 and 250 ms series of fuses. Implementation studies included optimization of granulation and binder selection, which affect durability and accuracy. The work provided knowledge about the combustion of gas-free mixtures, demonstrated their high accuracy, safety and implementability.
Scientific activity: Gerlich M., et al. Combustion Characteristics and Thermochemistry of Selected Silicon-Based Compositions for Time-Delay Detonators Materials, 2023. **140;** Gerlich M. et al. Oxide Mixtures as Gasless Time Delay Compositions for Mining Detonators Materials, 2023. **140:** Gerlich M. et al. Some aspects of the burning process of antimony and potassium manganate compositions. Materials. 2023. **140.** ***Awards*****:** Distinction of the Congress of the Polish Chemical Society NTREM 2024 - first prize of the scientific committee, NTREM 2022 - third prize.
1. **Mateusz GRATZKE** (2019-2024), ***PhD thesis topic:*** Synthesis and study of high-energy alkyl derivatives of nitroguanidin. ***Abstract***: A dissertation devoted to the synthesis and investigation of alkyl properties of nitroguanidine derivatives, prospective substitutes for 2,4,6-trinitrotoluene in explosive compositions formed into charges by molten casting. A method for the synthesis of 7 compounds from the alkyl nitroguanidins group containing carbon chains with a length of 1 to 4 carbon atoms was developed and optimized. A modification was undertaken, consisting in the introduction of explosive groups improving explosive parameters into the alkyl fragment, and it was possible to obtain 6 new compounds substituted with nitrate and azide groups. All obtained compounds were accurately characterized using 3 spectroscopic methods and examined for key properties such as melting point, density, sensitivity to mechanical stimuli and thermal stability. Thermochemical calculations were made to estimate the approximate explosive parameters. A derivative with optimal application properties, n-propylnitroguanidine, was used in an experimental explosive composition, for which key technological and explosive parameters were investigated. The developed composition is characterized by lower sensitivity to mechanical and thermal stimuli than TNT, while exhibiting higher explosive parameters. In addition, it does not contain nitroarens, which are substances harmful to the environment and personnel in ammunition factories.
Scientific activity: **5 publications:** the most important: Gratzke M. et al. Pyrolysis of Porous Organic Polymers under a Chlorine Atmosphere to Produce Heteroatom-Doped Microporous Carbons, 2021. **140;** Gratzke M. et al. Platinum group metal-free Fe-N-C catalysts for PEM fuel cells derived from nitrogen and sulfur doped synthetic polymers, 2022. **140;** Gratzke M. et al. The role of heteroatoms in iron-assisted graphitization of hard carbons derived from synthetic polymers, 2024. **140.**
Research internship: Erasmus+ scholarship, University of Pardubice, (2020). ***Projects:*** Project NCN/07-096/2020/WAT Porous carbon materials with mono nuclear coordination centres of type Fe-N4: universal (electro)catalysts of electroprotic reactions, (2021-2023).

4. materials engineering

Achievement Description

1 **Jan SOBIESKI** (2020-2025), ***PhD thesis:*** Optimization of the heterostructure of a semiconductor photodiode with HgCdTe obtained by the MOCVD method with high detection and operating without cryogenic cooling in the spectral range from 2 µm to 3.5 µm. (implementation doctorate). ***Abstract:*** The paper deals with the analysis and optimization of HgCdTe heterostructures for high-temperature IR detectors. The material properties, the MOCVD growth process and the IMP technique were evaluated. SIMS studies have shown residual non-diffuse of the layers that were removed by homogenizing annealing, improving the homogeneity and lifetime of the media. The developed photodiodes are characterized by lower dark current and achieve higher detection in the spectral range of 3.0–3.4 µm.
Scientific activity: 9 publications, including*:* Sobieski J. et al. Study of HgCdTe (100) and HgCdTe (111)B Heterostructures by MOCVD and Their Potential Application to APDs Operating in the IR Range up to 8 µm. Sensors, 2022, **140;** Sobieski J., et al. Midinfrared HgCdTe Heterostructure and Potential Application to APD Operation. IEEE Electron Device Letters, 2022, **140;** Sobieski J., et al. Non-Equilibrium Long-Wave Infrared HgCdTe Photodiodes. Materials, 2024, **140;** Sobieski, J. et al. Temperature Dependence of the Defect States in LWIR {100) and (111)8 HgCdTe Epilayers for IR HOT Detectors. Materials, **140.**
2 **Aleksandra Maria FIGAT** (2020–2025). ***Doctoral dissertation topic***: Nanoengineering of SERS substrates based on metallic nanoparticles produced by the reduction method with the use of α-amino acids. ***Abstract:*** The paper presents the results of comparative studies on the production of substrates for applications in SERS, in which the main components were nanoparticles (NC) produced by the method of reduction of metal salts using a-amino acids (a-AA) and glass and silicon substrates. The use of readily available components was aimed at producing effective as well as simple and low-cost SERS substrates. In my work, I tried to prove the thesis that "metallic nanoparticles obtained by the reduction method

using the a-AA method can be an effective strengthening plasmonic layer in the SERS substrate, which allows the detection of trace amounts of chemicals". In my studies, I used 20 protein salts and 1 non-protein a-AA salt as reducers and stabilizers in the synthesis of NC Au, analogous to the use of sodium citrate in the Turkevich method. NC Au was obtained in synthesis using 17 out of 21 a-AA subjects. The proposed modification of the Turkevich method was also validated for the synthesis of Ag nanoparticles. The combination of NC Au obtained with 5 selected a-AAs and 4 types of substrates (smooth and rough) yielded 17 potential SERS substrates, which were characterized together with their components using microscopic and spectroscopic techniques. The efficacy of the produced substrates in SERS was evaluated using 4-mercaptobenzoic acid and 1,2-bis(4-pyridyl) ethylene as test substances. Studies have shown that not all NC Au synthesized with a-AA can provide an effective reinforcing layer in SERS substrates. NC Au surface chemistry affects the fabrication and performance of SERS substrates. Among the SERS active substrates produced, the highest amplification coefficients were estimated for substrates produced with the use of NC Au synthesized from L-serine.
Scientific activity: **3 publications:** Figat M., et al. Monolayers of Amino Acid-Synthesized Gold Nanoparticles as SERS Substrates for Trace Chemical Sensing. Langmuir, **100;** Figat M., et al. Amino Acids as Reducing and Capping Agents. Langmuir, 2023, **100;** Figat M., et al. Surface-enhanced Raman spectroscopy in the detection and identification of chemical warfare agents and explosives. WAT, **100. *Projects:*** UGBWAT- Plasmonic nanoparticle layers as SERS substrates for the detection of trace amounts of hazardous substances, (2023); Strengthening CBRNE Security, Norway Grants, (2021-2024); GBMON- Spectral-oscillatory study of vibrational hazardous materials using Raman infrared spectroscopy, (2019-2022).
3 **Dominika PRZYGUCKA (GÓRNIEWICZ),** (2019-2023), ***PhD thesis topic:*** Concept of production of multicomponent TiCoCrFeMn sinter with the characteristics of HEA alloy strengthened by in-situ ceramic-intermetallic precipitations.
Abstract: A two-phase TiCoCrFeMn alloy was produced in the paper, consisting of a mixture of solid solution and Laves phase, and - in order to improve fracture resistance - additionally strengthened with CuO oxide ceramics introduced in-situ and Ti02 by ex-situ route. At the material design stage, a concept using molecular orbital theory was proposed to create a Bo-Md diagram as a tool for predicting the phase structure of titanium-based alloys. In addition, assuming the use of the designed alloy in the areas of "clean energy", including nuclear energy, the time taken into account by the constituent elements to reach the permissible level of radioactive contamination. The available design tools in the field of thermodynamic parameters of HEA were verified, confronting them with the designed diagram. At each stage of the production, consisting of mechanical synthesis of elemental powders, sintering of powder mixtures and homogenization carried out at a temperature of 1050°C for up to 1OOO hours, structural and phase studies were carried out, including X-ray phase analysis, differential thermal analysis and microanalyses of energy dispersion spectroscopy or backscattered electron diffraction, supported by microscopic observations. The identified elements of the microstructure were correlated with mechanical properties in terms of microhardness, resistance to brittle fracture and compressive strength. It was found that the obtained material is characterized by a combination of features typical of hard and brittle ceramics with thermal properties corresponding to nickel-based superalloys, predisposing the produced, two-phase high-entropic alloy to the anticipated applications.
Scientific activity**: 17 publications,** including: Górniewicz D., et al. TiCoCrFeMn (BCC + C14) High-Entropy Alloy Multiphase Structure Analysis Based on the Theory of Molecular Orbitals. Materials, 2021, **140;** Górniewicz D., et al. Effect of plasma nitriding process on the fatigue and high temperature corrosion resistance of Inconel 740H nickel alloy. Archives of Civil and Mechanical Engineering, 2022, **140;** Górniewicz D., et al. Microstructural evolution of 6061 aluminium alloy subjected to static and dynamic compression at low temperature, MRS Communications, 2023, **100. *Projects:*** OPUS 22 CoSMic: Complex alloys based on high-melting metal silicates produced by the process of liquid-phase infiltration (2022-present); Prelude 21 Effect of cobalt on the reduction of rutil-enhancing secretion - TiO2 in the high-entropy alloy CoCrFeMnTi (2022). Determination of the influence of triaxial elastic deformations on the actual hardness value in the Vickers test (2022). The influence of the applied atmosphere on the phenomena occurring during thermal treatments in the top layer of a high-entropy biphasic alloy (2021). ***Awards:*** LabSoft Special Award for AMT Conference Scientific Award (2023); Third degree award in the competition of the Rector of the Military University of Technology (2022).
4 **Katarzyna Tomczyk** (2021-....), ***PhD thesis:*** Anodic oxidation of AA 7075 series alloys in chromium-free electrolytes – "green" alternatives in corrosion protection. ***Subject of the dissertation****:* The subject of the dissertation includes the development of a new, "green" electrolyte for anodizing aluminum alloys from the AA7075 series, free of hexavalent chromium Cr(VI). The aim of the work is to obtain coatings with high corrosion resistance, competitive with Cr(VI) while eliminating it as a toxic component traditionally used in the electrolyte process. The originality and novelty of the research result from the use of chemical compounds not yet described in the literature, which are an alternative to commonly used chromate systems. The work is in line with the current requirements of the REACH regulation and the global efforts to eliminate Cr(VI), addressing one of the key technological challenges of the modern surface industry.
Scientific activity: Tomczyk K., et al. Spontaneous room temperature reaction of titanium and its alloys with hydrogen during self-shearing reactive milling. Chemical Engineering Journal, 2024, **200;** Tomczyk K., et al. Incorporation of Anions into Anodic Alumina-A New Track in Cr(VI) Anodizing Substitution. Materials, 2024, **140;** Tomczyk K., et al. Nanostructures Formed by Brass Electrochemical Oxidation Fabrication Strategies and Emerging Applications. Materials, 2025, **140.** ***Projects:*** NCN OPUS Electrochemical fabricated bimetallic nanostructures Cu-Zn as catalysts for efficient electrochemical reduction of carbon dioxide – fellowship holder (2022). ***Paper Awards***: 32nd Annual Anodizing Conference & Exposition (Seattle, USA); 33rd Annual Anodizing Conference & Exposition (Cleveland, USA); 4th International Symposium on AST 2025 (Kanagawa, Japan).

5. mechanical engineering

Achievement Description

1. **Janusz CHOJNOWSKI** (2020-2024), ***PhD thesis topic:*** Research of a dual-fuel power supply system for the

modernization of internal combustion engines of trucks. ***Abstract:*** The work is devoted to the analysis and research of a conventional dual-fuel installation powered by natural gas and diesel with an average replacement factor of more than 50% in the full range of engine loads, carried out on a chassis engine dynamometer and in road conditions. The utilitarian objectives of the work were research on market attractiveness and readiness for retrofitting, reviews of technological solutions and necessary mechanical modifications for dual-fuel engines, selection of low-emission fuels for modern dual-fuel solutions, development of tools and indication of key areas of research and development on retrofitting.
Scientific activity: **11 publications,** including: Chojnowski J, et al. A Review of Low-CO2 Emission Fuels for a Dual-Fuel RCCI Engine. Energies. 2021. **140;** Chojnowski J, et al. A review of technical solutions for RCCI engines. Combustion Engines. 2022. **70;** Chojnowski J, et al. Experimental Assessment of the Impact of Replacing Diesel Fuel with CNG on the Concentration of Harmful Substances in Exhaust Gases in a Dual Fuel Diesel Engine. Energies. 2022. **140;** Chojnowski J, et al. Influence of the Working Parameters of the Chassis Dynamometer on the Assessment of Tuning of Dual-Fuel Systems. Energies. 2022. **140;** Chojnowski J., et al. Criteria Analysis of Semi-Trucks with Conventional and Eco-Drives on the EU Market. Energies. 2024. **140.** ***Patents:*** Diagnostic and dynamometric station for installation and diagnostics of power supply systems for truck engines, **No. P.445699,** Mobile tool storage station, **No. P.445806**. ***Awards*****:** 2nd place in the BASF Poland - Drive Innovation competition (2022); Award of the MUT Rector for achievements in the field of scientific activity (2023).

2. **Mateusz OSZCZYPAŁA** (2020–2025) ***Topic of the dissertation:*** Modelling of reliability and readiness of trucks and passenger vehicles operating in military transport systems. ***Abstract:*** Studies were conducted on the reliability and readiness of Honker 2000 vehicles in three aspects, analysing the vehicle from the point of view of the technical object, the technical system and the component of the transport system. The waveform reliability function was determined using the Kaplan-Meier estimator. In the field of service life, semi-Markov models have been developed for reliability and readiness analysis. For the 4-state and 9-state models, readiness index values were calculated to be in the range of 0.90-0.91. Sensitivity analysis showed that a 50% reduction in repair waiting time would result in an increase in ratios of about 0.04. The Monte Carlo simulation model was used to determine the impact of use intensity on vehicle readiness. The analysis showed that an increase in the probability of assigning a transport task by 0.01 and an increase in the daily mileage by 1 km cause a decrease in the value of indicators. For the serial vehicle system, a reliability model was developed in the two-dimensional domain of vehicle lifetime and mileage based on Clayton domes. Reliability severity measures (BIM, CIM and BPIM) identified the engine, powertrain and electrical system as the most failing subsystems. As a result of the optimization of the structural redundancy levels of the system, it has been shown that when the transport fleet is reduced from 19 to 10 vehicles, the readiness of the system maintains the required levels of 0.95.
Scientific activity: **20 publications,** including: Oszczypała M., et al. Use of Artificial Neural Networks to Predict Fuel Consumption on the Basis of Technical Parameters of Vehicles, Energies, 2021, **140;** Oszczypała M., et al. Mathematical Programming and Solution Approaches for Transportation Optimisation in Supply Network, Energies, 2022, **140;** Oszczypała M., et al. Analysis of Light Utility Vehicle Readiness in Military Transportation Systems Using Markov and Semi-Markov Processes, Energies, 2022, **140;** Oszczypała M., et al. Optimization of the Delivery Time within the Distribution Network, Taking into Account Fuel Consumption and the Level of Carbon Dioxide Emissions into the Atmosphere, Energies, 2022, **140;** Oszczypała M., et al. A manufacturing feature recognition software based on Graph Neural Networks (GNNs) using PyTorch Geometric and NetworkX, SoftwareX, 2023, **200;** Oszczypała M., et al. Reliability analysis and redundancy optimization of k-out-of-n systems with random variable k using continuous time Markov chain and Monte Carlo simulation, Reliability Engineering and System Safety, 2023, **140;** Oszczypała M., et al. A novel approach to traffic modelling based on road parameters, weather conditions and GPS data using feedforward neural networks, Expert Systems with Applications, 2023, **200;** Oszczypała M., et al. A genetic algorithm and particle swarm optimization for redundancy allocation problem in systems with limited number of non-cooperating repairmen, Expert Systems with Applications, 2024, **200;** Oszczypała M., et al. Redundancy allocation problem in repairable k-out-of-n systems with cold, warm, and hot standby: A genetic algorithm for availability optimization, Applied Soft Computing, 2024, **200.**

3. **Damian SZUPIENKO** (2019-2023), ***Topic of the dissertation:*** Theoretical and experimental research of automatic firearms operating on the principle of barrel recoil. ***Abstract:*** The aim of the study was to conduct theoretical and experimental research of automatic firearms operating on the principle of short recoil of the barrel with a cam-lever accelerator, in terms of developing and validating a mathematical model of the operation of weapon automation operating on this principle. The first chapter presents an analysis of the state of world technology in the field of automatic firearms operating on the principle of barrel recoil, paying particular attention to the state of knowledge in the field of modeling the operation of automatic firearms. The next one, the short-recoil automation system with a cam-lever accelerator selected for experimental research is presented and theoretical models of its operation are formulated, and a model of internal ballistics of the analyzed projectile system is included, used to solve the Main Problem of Internal Ballistics (MPIB). In the next step, the energy and ballistic parameters of powder used in ammunition intended for experimental testing were determined experimentally necessary for the solution of MPIB. Next, the results of research on the energy and ballistic parameters of the material initiating the primer of ammunition intended for experimental tests are presented. Chapter Six contains the results of ballistic ammunition tests. The seventh part presents the results of experimental research on the automation system of the tested weapon in the form of displacement and speed of movement of the basic elements of the system. The eighth part describes the results of the validation of the developed theoretical models, extended by numerical verification of the correctness of the mathematical model of the system. The results of the work in the form of a developed and validated mathematical model of weapon automation can be successfully used by the defense industry and research units in the process of designing new and optimizing already used weapon designs.
Scientific activity**: 9 publications,** including: Szupieńko D., et al. Preliminary Physical and Mathematical Model of the Recoil Operated Firearm within the Bol Recoil Period, Problems of Mechatronics Armament Aviation Safety Engineering, 2020, **70;** Szupieńko D., et al. Investigation on influence of rifle automatics system action on values of energetic efficiency coefficient of muzzle brakes, Defence Technology, 2021, **100;** Szupieńko D., et al. Comparative Analysis of Different Methods of

Calculating Pressure Inside the Barret in Post-Muzzle Period of a Shot, Problems of Mechatronics Armament Aviation Safety Engineering, 2022, **70;** Szupieńko D., et al. Estimation of ignition pressure in ammunition, Energies, 2023, **140;** Szupieńko D., at al. Estimation of priming mixture forte, Energies, 2023, **140.** ***Awards:*** Diploma in the K. Siemienowicz Award Competition, International Conference on Scientific Aspects of Armament and Security Technology, 2020.

4. **Bartłomiej SARZYŃSKI** (2022-…), ***Topic of the dissertation:*** Studies of fatigue strength of selected joints of machine elements manufactured using the SLM technique. ***Subject:*** Studies of fatigue strength of selected joints of machine elements manufactured by the Selective Laser Melting technique – the subject of the dissertation is based on an innovative additive manufacturing technique. It is used to produce elements of a conical press connection. Then, half of them are subjected to the application of laser reinforcement paths on the surfaces of the bushings and journals in order to increase the bearing capacity of the joint through the appearance of the so-called structural spline. In order to compare the results, identical elements are produced from a conventional material. A key stage of the research is to carry out fatigue tests showing the ability to transfer the set torque through each of the connections, counted in the number of cycles until the connection loses.
Scientific activity: **10 publications,** including 8 with 140 points, the most important: Sarzyński B., et al. Metal Additive Manufacturing Applications in Production of Vehicle Parts and Components-A Review, Materials, **140;** Sarzyński B., et al. A Comparative Investigation of Properties of Metallic Parts Additively Manufactured through MEX and PBF-LB/M Technologies, Materials,**140**; Sarzyński B., et al. Bending Strength of Continuous Fiber-Reinforced Polyamide-Based Composite Additively Manufactured through Material Extrusion, Materials, **140.**

6. civil engineering, geodesy and transport

Achievement Description

1. **Aleksandra STACHERA** (2021-2025), ***PhD thesis topic:*** Multi-criteria method for determining the global energy intensity index of buildings. ***Abstract:*** The dissertation focuses on the development of a universal tool for assessing the energy performance of buildings, considering the complex interactions between materials, technologies and installations. The main objectives of the study were to develop a multi-criteria method enabling the selection of optimal structural, construction and installation solutions using the global building energy consumption index and to verify the method on the basis of case studies, including modernized and newly designed buildings. The paper develops a database of those affecting the energy consumption of buildings, defines the analysis criteria: relative annual final energy demand, cost, durability, payback time (modernized) or the number of investment outlay balance cycles (designed) and carbon dioxide emissions. Two ways of determining the global energy consumption index of a building have been proposed: a hybrid one consisting in a combined analysis of individual components and variants of structural, construction and installation solutions, and a direct one consisting in the evaluation of ready-made variants of solutions. The results of the case analysis of the modernized and newly designed building made it possible to formulate a recommendation for determining the global energy intensity index. The results indicate the high effectiveness of the developed method, to indicate the most advantageous solution.
Scientific activity: **4 publications,** the most important: Stachera A., et al. A Method of Multi-Criteria Assessment of the Building Energy Consumption, Energies 2023, **140;** Stachera A., et al. Possibilities of regulating thermal comfort and characteristics of radiator operation in a room in a large slab building, Energy Market. 2023, **70.** ***Research internship:*** Deepening knowledge in the field of issues related to the topic of the doctoral dissertation, Kielce University of Technology, 2022.

2. **Kamil SOBCZYK** (2019–2023) ***Doctoral dissertation topic***: Experimental analysis of dynamic mechanical properties of doubtful soils on the example of silty sand. ***Abstract:*** I proposed an original methodology for preparing a soil sample for experimental analyses at the SHPB stand, taking into account different values of soil moisture. I have developed a solution for the process of pre-compaction of the soil through the vibration compaction procedure and the calibration method of the pneumatic launcher for the type of projectile load rod used. I have implemented a procedure for a comprehensive analysis of the effects of dynamic impact on silty sand, taking into account changes in the granulometric composition of this soil depending on: the content of fine fractions, the adopted configuration of variants of the initial pressure of the launcher acting on the projectile-loading rod and the moisture content of these soil samples. During the implementation of the work on the dynamic behavior of a selected representative of doubtful soils of dusty sand, I developed an original solution to a defined scientific problem. I have presented them in a collection of five thematically related scientific articles. In the research considerations included in the series, I have shown that the dynamic mechanical properties of the three-phase doubtful soil, which is the tested dusty sand, are of a nonlinear nature. I determined that they depend on its humidity, granulometric composition and deformation rate. In the dissertation, I proved the research thesis: The dynamic mechanical properties of three-phase doubtful soil, on the example of dusty sand subjected to a compressive impact, are nonlinear in nature and depend on soil moisture, its granulometric composition and are sensitive to the speed of deformation. The results of the tests make it possible to determine the parameters of dynamic load energy absorption through the protective layer of the soil, which makes it possible to determine the level of both ballistic and explosion protection for hiding places and shelters.
Scientific activity: **18 publications,** the most important: Sobczyk K., et al. Experimental investigation of dynamic behavior of silty sand, Archives of Civil Engineering, 2021,**100;** Sobczyk K., et al Strength Characterization of Soils' Properties at High Strain Rates Using the Hopkinson Technique - A Review of Experimental Materials, 2022, **140;** Sobczyk K., The impact of improper recognition of the subsoil on the implementation of investments in a closed area, Building Materials, 2022, **100.** ***Research Internship:*** Air Force Institute of Technology (2022). ***Projects:*** Development and production of a prototype of an innovative composite scaffolding (2020).

3. **Wojciech DAWID (**2019-2024), ***Dissertation topic:*** Development of a methodology for determining the possibility

of the terrain considering microsculpture. ***Abstract:*** The scientific work focused on solving problems related to modelling the possibility of the terrain at the detailed level for individual vehicles. I used high-resolution numerical terrain models and traction parameters of vehicles, applying the principle of analytical geometry in three-dimensional space. I have shown that maps based on data with a resolution of 1 m from aerial laser scanning are optimal. I conducted research, using the developed maps to determine the routes. Dijkstra's algorithm proved to be more effective than A*, guaranteeing speed and repeatability of results. The case study confirmed the effectiveness of the developed methods in real crisis situations. I improved the process by allowing routes to be determined without prior preparation of roadworthiness maps. The final methodology integrates all the developed solutions, enabling the automatic generation of roadmaps and routes for different vehicles in different terrains. The tests confirmed the effectiveness of the methodology, and its automatic nature and the inclusion of the microsculpture in real time make it widely applicable in the planning of emergency response operations, contributing to time savings and the efficiency of rescue operations.
Scientific activity*: 10 publications,** the most important: Dawid W., et al. Analysis of the possibilities of using different resolution digital elevation models in the study of microrelief on the example of terrain possibility. Remote Sensing, 2020,**100;** Dawid W., et al. Methodology of using terrain possibility maps for planning the movement of troops and navigation of unmanned ground vehicles. Sensors, 2021, **100;** Dawid W., et al. The methodology of determining optimum access routes to remote areas for the purposes of crisis management. International Journal of Digital Earth, 2022, **100.** ***Projects: Intelligent, integrated system for location, initial assessment and medical assistance to victims on the battlefield (2021-2025). Automated system for determining the possibility of roads and terrain (2023-2025).

4. **Kinga KARWOWSKA** (2020-2024), ***PhD thesis:*** Development of a methodology for increasing the spatial resolution of imagery from small satellites using artificial intelligence algorithms. ***Abstract:*** In recent years, small satellites have become increasingly popular. However, they have a significant disadvantage due to the design, they have a much weaker spatial resolution. Therefore, it is necessary to develop a method to improve spatial resolution based solely on low-resolution images. As part of the dissertation, I proposed a new methodology for improving the spatial resolution of satellite scenes. It consists of three stages: (1) dividing the image into smaller fragments of a size corresponding to the input neural network (SN), (2) improving the resolution using SN, (3) merging the reconstructed tiles into a single image using a time window. The key element of the solution is the generative opposing network, for which I used a multi-column discriminator and the Wasserstein loss function. The modifications introduced significantly accelerated the network training process and improved the quality of estimated images (SR). The research was concluded with the development of a methodology for improving the spatial resolution of the sequence of images acquired by small satellites. In order to further improve the quality of SR images, I have expanded the GAN generator with an encoder-decoder network. The modification improved the interpretive quality of the images generated by the generator. The developed methodology allows for a fourfold improvement in resolution and at least a two-fold increase in the interpretive potential of images from small satellites.
Scientific activity*: 6 publications,** the most important: Karwowska K., et al. A Systematic Review, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2022, **140;** Karwowska K., et al. Improving Spatial Resolution of Satellite Imagery Using Generative Adversarial Networks and Window Functions, Remote Sensing, 2022, **100;** Karwowska K., et al. Improving Enhanced Super-Resolution Generative Adversarial Network for Satellite Images, IEEE Remote Sensing, 2023, **140.** ***Projects: SZAFIR/09/A/010/01/2021 Integrated system for localization, initial assessment and medical assistance to victims on the battlefield (2021-present); SZAFIR/09/A/022/01/2021 Nano satellite constellation of optoelectronic imaging reconnaissance PIAST (2021-present); Research Grant 423/2022/Da/GB2 Automatic detection and identification of military equipment on satellite imagery. ***Awards:*** 1st place in the MoD Competition for the development of the concept and implementation of the design of an unmanned system for applications related to national defence and security.

7. information and communication technology

Achievement Description

1. **Damian FRĄSZCZAK** (2019-2023), ***PhD thesis topic:*** Method of detecting sources of fake news in social networks. ***Abstract:*** In the face of access and the growing influence of social networks on the formation of public opinion, the problem of identifying the sources of propagation of fake news is becoming a key issue. The aim of the study was to develop advanced techniques for identifying sources of disinformation. The dissertation analyses the available solutions to the problem of identifying sources of disinformation in social networks. Their strengths and weaknesses were identified and improvements were proposed. In this respect, an innovative contribution was made by developing a dedicated analytical and simulation tool RPaSDT constituting the basis for future research. For the first time, the problem of identifying propagation foci was defined as a key aspect of the problem of identifying the sources of fake news, and the first such detailed research of network partitioning techniques in the context of source identification was conducted. Based on the analyses, a new method of detection of foci – BLOCD, more effective in both the location of foci of propagation and detection of sources, was proposed. In the context of the task of reconstructing propagation graphs, the SHNI technique was proposed. Despite its low computational complexity, this method has obtained satisfactory results. In addition, an error has been identified in the previous assumptions about the single-source nature of propagation foci. A new approach was proposed to select multiple sources within a single outbreak. The added value is the confirmation that team techniques are more effective in identifying sources of disinformation than single methods. The application of the developed techniques in the real case of the disinformation campaign regarding the alleged illness of Pope Francis from Covid-19 confirmed their effectiveness. The conclusions of the dissertation represent a significant step forward in the fight against disinformation, introducing innovative, empirically validated methods to identify sources of false information.
Scientific activity: 12 publications, the most important: Frąszczak D., NEFBDAA-NET Environment for Building Dynamic

Angular Applications, SoftwareX, 2022, **200;** Frąszczak D., RPaSDT-Rumor Propagation and Source Detection Toolkit, SoftwareX, 2022, **200;** Frąszczak D. Detecting rumour outbreaks in online social networks, Social Network Analysis and Mining, 2003, **100.**

2. **Joanna SZKUTNIK-ROGOŻ** (2020–2024). ***Dissertation topic:*** Computer aided modelling and optimization of strategies for dealing with selected problems, including reliability, in transport systems. ***Abstract:*** The dissertation presents a group of models and methods in the field of optimization of strategies supporting decision-making processes in the field of transport, considering the reliability of facilities. The description of the results of the dissertation is divided into five chapters. The first part reviews the literature on the issues related to modelling and optimisation of computer-aided decision-making strategies in transport systems, and the second part presents the conclusions resulting from the literature review. The third chapter describes the models, methods and research techniques used. The fourth chapter, concerning mathematical modelling and optimisation of strategies in transport systems, presents the original results of research conducted by the author of this dissertation. The results obtained confirmed that the developed methodology of the procedure allows for the optimization of selected fragments of the decision-making process in transport systems. This dissertation is a summary of a series of scientific publications and is a synthetic description of research and the results obtained.
Scientific activity: **12 publications,** the most important: Szkutnik-Rogoż J. et al. Use of Artificial Neutral Networks to Predict Fuel Consumption on the Basis of Technical Parameters of Vehicles, Energies, 2021, **140;** Szkutnik-Rogoż, J., et al . Mathematical Programming and Solution Approaches for Transportation Optimisation in Supply Network, Energies, 2021, **140;** Szkutnik-Rogoż, J. et al. Optimization of the Delivery Time within the Distribution Network, Energies, 2022, **140.**
Research fellowship: Senior Garrison Security Unit, Warsaw, (2021). ***Projects:*** UGB No. 747/WAT/2020 - Application of computational methods for the analysis, evaluation and improvement of the process of operation of facilities part 1 (2020) part 2, UGB no. 878/2021 (2021).

3. **Tomasz WALCZYNA** (2021-2025), ***PhD thesis:*** Active identity protection in facial images using tamper-proof deepfake watermarking. ***Abstract:*** The dissertation addresses the problem of threats related to the development of deepfake technology, which enables realistic manipulation of images. The research gap lies in the lack of protection methods that would allow not only to detect manipulation, but also to actively recover lost identity. The thesis assumes that neural network models can hide a compact representation of identity in an image and enable its reconstruction after deep fake manipulations. Four research objectives were achieved as part of the work: analysis of identity manipulation schemes in image and sound, development of own, controllable deepfake generators for research on watermark resistance, investigation of methods of hiding data in images and their behaviour in the face of manipulation, design of a watermarking method enabling the reconstruction of identity after face-swap. For m.in, autoencoders, generative GAN networks, U-Net architectures and embedding models (ArcFace) were used. It has been shown that: deepfake processing pipelines can be unified into an analysis-mapping-reconstruction scheme, it is possible to build generators that allow for gradual control of the force of manipulation, a watermark can carry redundant semantic information, allowing reconstruction even after strong degradation. The proposed RE-Mark method makes it possible to recover the appearance of the face after face-swap manipulation from a single image, while maintaining visual transparency. The results contribute to the field of active protection against multimedia manipulation and indicate directions for further development.
Scientific activity: 8 publications, including: Walczyna T., et al., Overview of Voice Conversion Methods Based on Deep Learning, Applied Sciences, 2023, **100;** Walczyna T., et al. Quick Overview of Face Swap Deep Fakes, Applied Sciences, 2023, **100;** Walczyna T., et al. Fast Fake: Easy-to-Train Face Swap Model, Applied Sciences, 2024, **100;** Walczyna T., et al, Change and Detection of Emotions Expressed on People's Faces, Applied Sciences, 2025, **100.** ***Projects*****:** SOFTANET (2024); CRAI 1 (2025); LORACO (2024-2026).

4. **Paweł DUSZEJKO** (2021-2025). **Doctoral dissertation topic:** An effective method of active detection and analysis of manipulation in high-resolution images using a watermark. **Abstract:** The increase in the availability of editing and generative tools has led to a situation in which modifying the content of digital images has become not only common, but also difficult to detect. Existing passive methods prove to be insufficient, and active methods are the answer, using watermarking techniques for the purpose of detecting and analysing changes. However, their effectiveness is still limited by aspects such as compatibility with high resolutions, resistance to technical degradation, and the ability to localize and classify modifications. The aim of the dissertation was to develop a scalable method of active manipulation detection in high-resolution images using brittle and semi-brittle watermarks, embedded and interpreted using deep neural networks. The proposed concept combines forensic analysis and deep learning approaches to create a system capable of detecting, locating, classifying, and attributing the source of transformed images. A key feature of the method is resistance to non-semantic transformations, while at the same time being highly sensitive to manipulations that change the content of the scene. An intermediate resolution processing strategy is used, which maintains a near-constant computational load regardless of the input format and enables practical use in images even at 8K resolution. The dissertation presents three successive stages of system development, the 4KSecure architecture, the Resolution-Agnostic Semi-Fragile Watermarking method and DualSecure. The experimental results showed that the developed systems achieve high efficiency (AUC>0.97dB) for manipulation location) while maintaining transparency (PSNR>60dB) and resolution flexibility. Thanks to its modular design and selective sensitivity to semantic interference. The dissertation consists of two parts, the first presents the scientific and methodological justification, includes a description of research problems, a formal model, and an analysis of literature and experimental results. The second part contains a full cycle of scientific publications that are the basis for the verification of the thesis and research problems.
Scientific activity: 11 publications**,** including: Duszejko P., Detection of Manipulations in Digital Images: A Review, Applied Sciences, 2025 **100;** Duszejko P., et al. 4KSecure: A Universal Method for Active Manipulation Detection in Images of Any Resolution. Applied Sciences, 2025, **100;** Duszejko P., et al. Resolution Agnostic Semi Fragile Watermarking for Image Integrity and Manipulation Analysis, TechRxiv, 2025, **100;** Duszejko P., et al. A Resolution-Agnostic Semi-Fragile Watermarking for Image Integrity and Source Attribution, TechRxiv, 2025, **100.** ***Projects:*** SOFTANET (SOFtware Defined

Tactical and TheAtre NETwork) (2023); Projekt Adspective (2023-2025).

ATTACHMENTS

Adequacy of the education program and individual research plans to the learning outcomes for qualifications at PRK level 8 and their implementation

No.	File type	Filename
1	Education programmes during the evaluation period	Programy_kształcenia_SDR_2019-2025_ang.pdf
2	Education programmes during the evaluation period	Wzory_IPK_IPB_KIP_ang.pdf

Method of verifying learning outcomes for qualifications at PRK level 8

No.	File type	Filename
1	The method of assessing the learning outcomes for qualifications at level 8 of the PQF	Zestawienia_efektów_uczenia_się_ang.pdf
2	The method of assessing the learning outcomes for qualifications at level 8 of the PQF	Wzory_sprawozdań_SDR_ang.pdf
3	The method of assessing the learning outcomes for qualifications at level 8 of the PQF	Regulamin_praktyk_i_innych_form_kształce

Qualifications of academic teachers or research staff conducting education at the doctoral school

No.	File type	Filename
1	automation, electronics, electrical engineering and space technologies	Wizytówki_AEEiTK_ang.pdf
2	civil engineering, geodesy and transport	Wizytówki_ILBiT_ang.pdf
3	information and communication technology	Wizytówki_ITT_ang.pdf
4	materials engineering	Wizytówki_IMA_ang.pdf
5	mechanical engineering	Wizytówki_IME_ang.pdf
6	chemical sciences	Wizytówki_NCH_ang.pdf
7	security studies	Wizytówki_NoB_ang.pdf

Quality of the recruitment process

No.	File type	Filename
1	The admissions rules of the doctoral school during the evaluation period	Zasady_rekrutacji_do_SDR_201
2	The compositions of the admissions committees during the evaluation period and the rationale for their selection with the aim of maintaining high admission standards	Komisje_rekrutacyjne_i_zespoły
3	The regulations of the doctoral school during the evaluation period	Zasady_rekrutacji_do_SDR_201

Quality of scientific or artistic supervision and support for conducting scientific activities

No.	File type	Filename
1	Internal regulations that pertain to the midterm evaluation and that are in force during the evaluation period, such as evaluation rules and criteria	Kryteria_oceny_śródokresowej_2022_an
2	Internal regulations that pertain to the midterm evaluation and that are in force during the evaluation period, such as evaluation rules and criteria	Harmonogram_oceny_śródokresowej_20
3	Internal regulations that pertain to the midterm evaluation and that are in force during the evaluation period, such as evaluation rules and criteria	Komisja_ds_oceny_śródokresowej_2021
4	Internal regulations that pertain to the midterm evaluation and that are in force during the evaluation period, such as evaluation rules and criteria	Raport_śródokresowy_2021-2024_ang.p

STATEMENTS

- I hereby declare that the information contained in the self-assessment report is fully consistent with the factual and legal status.
- I hereby declare that the information contained in the self-assessment report in Polish and English is fully identical in substance.
- I hereby declare that the documents attached to the self-assessment report in Polish and English are fully identical in substance.

Signature

Piotr Zalewski

Elektronicznie podpisany przez Piotr Zalewski
Data: 2025.11.28 08:21:21 +01'00'

AUTHORIZATIONS

Added files

RKR-06_upoważnienie_SDR_Raport.pdf

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 36/WAT/2019 of 30 May 2019

on the establishment of the "Curriculum at the Doctoral School Military University of Technology"

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (Journal of Laws, item 1668, as amended), in conjunction with Article 291 of the Act of 3 July 2018. Provisions introducing the Law on Higher Education and Science (Journal of Laws, item 1669, as amended), the following is resolved:

§ 1

The *Education Program at the Doctoral School of the Military University of Technology is established,* which is attached to the resolution.

§ 2

The curriculum referred to in § 1 has been in force since the academic year 2019/2020.

§ 3

The resolution shall enter into force on the date of its adoption.

President of the Senate

(--) Brig. Gen. Tadeusz SZCZUREK, PhD, DSc, Eng.

CURRICULUM

AT THE DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

I. General principles

1. The curriculum at the Doctoral School of the Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics and electrical engineering** - a field of engineering and technical sciences;
    2) **technical informatics and telecommunications** - a field of engineering and technical sciences;
    3) **civil engineering and transport** - a field of engineering and technical sciences;
    4) **materials engineering** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security sciences** - a field of social sciences;
    7) **Chemical sciences** - a field of exact and natural sciences.

2. The learning outcomes take into account the requirements specified for the 8th level of the Polish Qualifications Framework.

3. Number of semesters: **8**

4. The total teaching load is at least 300 hours and corresponds to at least 30 ECTS credits**.**

5. Language: **Polish**

6. The program is valid from: **recruitment 2019/2020**

7. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:

    Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is to prepare doctoral students ready to serve the Polish State – in broadly understood aspects, both military and civilian, in accordance with the principle "Omnia Pro Patria" – "Everything for the Homeland".

8. Prerequisites for the candidate for the Doctoral School

    The candidate has a Level 7 qualification. Polish Qualifications Framework (Master's degree, Master's degree in engineering or equivalent) and graduated in a field related to the scientific discipline conducted at the Doctoral School. Detailed requirements are set out in the rules of recruitment to the Doctoral School established by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for modules for which the university learning outcomes are required;
2) in the code column - reference of the assumed learning outcome to the appropriate code of the component of the description of the first- and second-cycle characteristics of learning outcomes at level 8 of the characteristics of the Polish Qualifications Framework (8.PQF).

Effect number symbols	**Expected learning outcomes**	**code 8 PQF**
	Knowledge: the graduate knows and understands	
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
	Skills: the graduate is able to	
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8S_UW*
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	*P8S_UW*

Effect number symbols	Expected learning outcomes	code 8 PQF
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: − define the purpose and object of scientific research, formulate a research hypothesis, − develop research methods, techniques and tools and apply them creatively, − draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8S_UK*
D_U10	*participate in scientific discourse*	*P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	*P8S_UU*
D_U14	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*
	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_KK*
D_K02	*taking into account the challenges in the professional and public sphere, taking into account: – their ethical dimension, – responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8S_KK*
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8S_KO*
D_K07	*initiating activities in the public interest*	*P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including: − conducting scientific activity in an independent manner, − respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- a course credit, the form of which is determined by the course coordinator, or an opinion after completing an internship, domestic or foreign internship;
- a doctoral seminar at which the doctoral student presents an analysis of the research area to which he or she is to devote his or her research;
- opinion after completing the professional practice, if it is provided for in an individual education program;
- edited doctoral dissertation.

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.
2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.
3. The curriculum includes at least 300 hours of classes and up to 180 hours of professional internships - at least 30 ECTS credits in total.
4. The curriculum consists of:
   1) the basic module for all scientific disciplines conducted at the Doctoral School, in the amount of 100 hours with a total of 10 ECTS credits;
   2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned;
   3) apprenticeships of up to 180 hours – max. 60 hours per year from the third semester (if provided for in an individualised learning programme).
5. A doctoral student must complete the basic module. A doctoral student, in consultation
   with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. Subjects from different scientific disciplines are allowed.
6. By the end of the first semester of education, the doctoral student submits to the director of the Doctoral School, agreed with the supervisor, an individual curriculum in the field of subjects of the optional module.
7. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year.
8. Classes in the subjects of the optional module, if the number of doctoral students enrolled in a given course is less than 5, are planned on an individual basis according to individual curricula.
9. In the case of a domestic or foreign internship, the supervisor determines the number of ECTS credits credited to the doctoral student as part of the optional module, not more than 5 points per semester of the internship or internship.
10. Classes are held in accordance with the education plan (general and individual) and are carried out according to the semester timetables in force at the Academy.

V. Modules of the curriculum

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, compulsory for doctoral students of all disciplines (I-II sem.)				
1.	Higher education	20	2	D_WWAT01, D_W05, D_W06, D_UWAT01, D_U13, D_K01, D_K02
2.	Principles of conducting classes and self-presentation techniques	10	1	D_WWAT01, D_UWAT01, D_U13, D_U14, D_K01, D_K06
3.	The process of applying for research funding	10	1	P8U_U, P8S_UW,P8S_UO P8S_UU,D_K01,P8U_K, D_K03,P8S_KK,D_K04
4.	Organizational, legal and ethical aspects of scientific work	10	1	D_W06, D_U12, D_U13
5.	Methodology of conducting scientific research	10	1	D_WAT02, D_U01-U05
6.	Ownership and commercialisation of research	10	1	D_W05, D_W06,D_U06
7.	Principles of writing a scientific paper	10	1	D_W05, D_W06, D_U07
8.	Analysis of the research area - seminar	20	2	D_W01, D_W02, D_W03, D_W4, D_U08
Optional modules related to the scientific discipline (III-VIII sem.):				
1	Automation, Electronics & Electrical Engineering	min. 200 hrs	min. 20 pkt ECTS	*Annex V.1 - page 11*
2	Informatics and Telecommunications			*Appendix V.2 – p. 13*
3	Civil Engineering and Transportation			*Annex V.3 – page 15*
4	Materials Science			*Appendix V.4 – p. 16*
5	Mechanical Engineering			*Annex V.5 – p. 17*
6	Chemical Sciences			*Annex V.6 – page 20*
7	Security Sciences			*Annex V.7 – p. 21*
Apprenticeships (III-VIII sem.) - in accordance with the individual curriculum				
1	in the form of conducting classes or participating in conducting them	0-180 hrs	0	*D_WWAT01, D_UWAT01 D_K01*

Note: *A detailed list of subjects for optional modules is provided in Annexes V.1 to V.7*

VI. Framework Programme

The framework programme includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

Lp.	Course/Module Name	Curriculum content/notes
Basic module, compulsory for all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Principles of conducting classes and self-presentation techniques	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	The process of applying for research funding	Classes devoted to the processes of applying for funding of basic scientific research and research related to statutory activities, financing of domestic and foreign scientific internships, addressed especially to young scientists at the beginning of their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Science and Higher Education, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Organizational, legal and ethical aspects of scientific work	The Law on Higher Education and Science (Constitution of Science). Organization of research activities at the university on the example of the Military University of Technology. A model of scientific career in Poland. Parametric evaluation of an academic teacher and a research unit (discipline). Foreign internships and scholarships as part of a scientific career. Formal and substantive activities for the implementation of the doctoral dissertation. Principles of ethics in scientific research and in scientific careers.
5.	Methodology of conducting scientific research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that needs to be solved – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6	Ownership and commercialisation of research	The curriculum provides doctoral students with basic information on the methods of intellectual property protection (in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection). During the course, the issues of commercialization of the results of scientific research and development work will also be discussed.
7	Principles of writing a scientific paper	The Law on Higher Education and Science (Constitution of Science). types of doctoral dissertations, requirements for doctoral dissertations, structure of a doctoral dissertation, edition of a doctoral dissertation, examples of doctoral dissertations, examples of reviews of doctoral dissertations.
8.	Analysis of the research area	Seminar classes, during which the doctoral student presents the area of knowledge to which he or she is to devote his or her research, the current state

Lp.	Course/Module Name	Curriculum content/notes
		of knowledge in this area. Presents a draft schedule for the implementation of the research project in order to collect comments, suggestions and make corrections. Together with the supervisor, he develops an individual education program.
Optional modules related to the scientific discipline:		
1	Automation, Electronics & Electrical Engineering	*Annex VI.1 – page 22*
2	Informatics and Telecommunications	*Annex VI.2 – page 31*
3	Civil Engineering and Transportation	*Annex VI.3 – page 40*
4	Materials Science	*Annex VI.4 – page 45*
5	Mechanical Engineering	*Annex VI.5 – page 50*
6	Chemical Sciences	*Annex VI.6 – page 63*
7	Security Sciences	*Annex VI.7 – page 67*

Note: *a detailed list of subjects of optional modules and their curricular content is presented in Annexes VI.1-VI.7*

VII. Method of organizing apprenticeships: forms and principles of implementation

Practical placements (if provided for in an individualised learning programme) are carried out primarily in the form of teaching or participation in classes. Other forms are allowed, decided by the supervisor, in special and justified cases (disability of the doctoral student) the doctoral student may be exempted from the obligation to undergo professional practice.

Internships are subject to credit for a descriptive grade (*zal / nzal*) from the academic year in which they took place. The credit is made by the head of the unit in which the internship was carried out. In other cases, the count is made by the supervisor or director.

VIII. Educational plan

The education plan consists of a general part for all doctoral students of the year, and an individual education plan for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

An individual education plan is created for each doctoral student who, in consultation with the supervisor from the optional module for the scientific discipline (or from others), selects the courses to be implemented. Selected classes will be planned from the third to the sixth semester, it is recommended that the semester workload of the doctoral student should be even - at the level of 5 ECTS points.

Wojskowa Akademia Techniczna

PLAN KSZTAŁCENIA W SZKOLE DOKTORSKIEJ

WSZYSTKIE DYSCYPLINY NAUKOWE PROWADZONE W SZKOLE DOKTORSKIEJ

	moduły/*przedmioty*	ogółem godzin/ pkt ECTS		liczba godzin/pkt ECTS w semestrze:															
				I		II		III		IV		V		VI		VII		VIII	
		godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS
	Moduł podstawowy, obowiązkowy dla wszystkich dyscyplin	**100**	**10**	**50**	**5**	**50**	**5**												
1	*Dydaktyka szkoły wyższej*	**20**	**2**	**20**	**2**														
2	*Przegotowanie do zajec dydaktycznych i techniki autoprezentacji*	***10***	***1***	***10***	***1***														
3	*Proces wnioskowania o finansowanie badań naukowych*	***10***	***1***			***10***	***1***												
4	*Orgqnizacyjne, prawne i etyczne aspekty pracy naukowej*	***10***	***1***			***10***	***1***												
5	*Metodologia prowadzenia badań naukowych*	***10***	***1***			***10***	***1***												
6	*Prawa własnosci komercjalizacja badań naukowych*	**10**	**1**			**10**	**1**												
7	*Zasady pisania pracy naukowej*	**10**	**1**			**10**	**1**												
8	*Analiza obszaru badawczego*	**20**	**2**	**20**	**2**														
	Moduły fakultatywne związane z dyscypliną naukową:																		
1	**Automatyka, eletronika i elektrotechnika**	**min. 200 godz.**	**min. 20 pkt ECTS**					**Zgodnie z indywidualnym programem kształcenia liczba godzin zajęć co najmniej 200 godz. i 20 pkt ECTS**											
2	**Informatyka techniczna i telekomunikacja**																		
3	**Inżynieria lądowa i transport**																		
4	**Inżynieria materiałowa**																		
5	**Inżynieria mechaniczna**																		
6	**Nauki o bezpieczeństwie**																		
7	**Nauki chemiczne**																		
	Praktyki zawodowe - zgodnie z indywidualnym programem kształcenia																		
1	*w formie prowadzenia zajęć lub uczestnictwa*	**0-180**						**0-180 godzin - zgodnie z indywidualnym programem kształcenia**											

Note: *The number of traineeships (if provided for in an individualised learning programme) is up to 60 hours per year, starting from the third semester.*

IX. Internal system for ensuring the quality of education at the Doctoral School

The internal education quality assurance system at the Doctoral School is an element of the Education Quality Assurance System at the Military University of Technology.

As part of the preparation of doctoral students for high-level research work, the importance of continuous monitoring and systematic improvement of the quality of their education increases. The education quality policy, resulting from the mission and development strategy of the Academy, is implemented at the Academy by setting appropriate goals and quality standards, as well as by implementing, continuously monitoring
and improving the internal quality assurance system.

The scope of the internal education quality assurance system at the Doctoral School includes in particular:

1) monitoring and analysis of the formal and legal side of the teaching process;
2) periodic review and updating of education programs;
4) analysis of the conditions for the implementation of the teaching process;
5) monitoring factors affecting the quality of education;
6) analysis of the functioning and development of methods for improving the quality of education.

Annex V.1

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Administration of computer networks II	20	3	*D_W03*
2.	Computer-aided analysis of experimental data	30	3	*D_W03, D_U06*
3.	Biology and biomedicine – modern research techniques	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
4.	Digital Image Processing	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
5.	Optical Radiation Detectors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
6.	Electromechanical energy and signal converters	30	3	*D_W01, D_U05*
7.	English for electronics	20	2	*D_W03, D_U04, D_K01*
8.	Laser Physics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
9.	Physics of laser media	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
10.	Photovoltaics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
11.	Functionalised optoelectronic nanomaterials	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
12.	Supercontinuum Radiation Generation	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
13.	Imaging Information Engineering	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
14.	Encoding and recognition of radio transmissions	30	3	*D_U05*
15.	Crystallography	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
16.	Laser absorption spectroscopy in gas sensors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
17.	Laser-plasma X-ray and extreme ultraviolet (EUV) sources	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
18.	Lasers for medical applications	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
19.	Pico- and femtosecond lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
20.	Fiber lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
21.	Mathematical models of the electromagnetic field	20	2	*D_W02, D_W03*
22.	Finite Element Method	30	3	*D_W02, D_W03*
23.	Methods of analysis and measurement of random signals	30	3	*D_W02, D_U05*
24.	Data mining methods and tools	30	3	*D_W02, D_W04*
25.	Numerical methods	30	3	*D_W01, D_W03*
26.	Methods of logical synthesis	30	3	*D_W02, D_W03*
27.	Surveying and optoelectronic measurements	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
28.	Modeling of physical phenomena and processes	30	2	*D_W01, D_W02, D_W03 D_U04, D_K03, D_K05*
29.	Nonlinear Laser Conversion	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
30.	Scientific and engineering calculations	30	3	*D_W04*
31.	Optoelectronics in safety systems	30	2	*D_W01, D_W02, D_W03*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
				D_U010, D_K03, D_K05
32.	Laser optics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
33.	Coherent Light Optics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
34.	Plasma in science and technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
35.	Remote Sensing Basics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
36.	Designing safety systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
37.	Programmable and Purpose-Built Circuits	30	3	*D_W01, D_U05*
38.	Selected problems of digital signal processing	30	3	*D_W01, D_W03*
39.	Acoustic sensors	20	2	*D_W04, D_W05*
40.	Microwave sensors in radiolocation	20	2	*D_W02, D_U04*
41.	Smart radio networks	30	3	*D_W01, D_W03*
42.	Optical Spectroscopy for Life Sciences	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
43.	Digital systems in optoelectronic devices	30	2	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*
44.	Test and measurement systems in the test laboratory	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
45.	Fiber optic technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
46.	Terahertz technique	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
47.	Information Concealment Technique	30	3	*D_W01, D_W02, D_U05*
48.	Thin film technologies	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
49.	Thermal imaging and infrared technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
50.	Optical Radiation Detection Systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
51.	Modern transducers measuring physical quantities	30	3	*D_W01, D_U05*
52.	Selected issues of the operation of anthropotechnical systems	30	3	*D_W08, D_U05 i 06*
53.	Selected issues of vibration theory	20	2	*D_W02*
54.	Selected issues of modern programming – introduction to modern programming languages	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
55.	Selected issues in acoustoelectronics	30	3	*D_W04, D_W05*
56.	Advanced microelectronics technologies	30	3	*D_W01, D_U05*
57.	Applications of lasers in technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*

Annex V.2

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: technical informatics and telecommunications

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Quantum Algorithms III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
2.	Algorithm Analysis III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
3.	Analysis and synthesis of visual information III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
4.	ICT Systems Diagnostics III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
5.	Efficiency of ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
6.	Elements of forecast theory III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
7.	Software Evaluation III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
8.	Physical Foundations of Quantum Information III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
9.	Computer Graphics III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
10.	Software Quality Engineering III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
11.	Cryptology III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
12.	Mathematical Methods of Decision Support III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
13.	Discrete Mathematics III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
14.	Generative and Aspective Methods in Software Development III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
15.	Numerical methods III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
16.	Multi-Criteria Optimization Methods III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
17.	Mathematical Modelling III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
18.	Modeling and verification of ICT networks III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
19.	Modeling human-computer interaction III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
20.	Modeling Conflict Situations III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
21.	Business Process Modeling, Simulation and Analysis III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
22.	Software Reliability III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
23.	Reliability of Systems III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
24.	Optimization III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
25.	Probabilistic III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
26.	Stochastic Processes III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
27.	Image Recognition and Processing III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
28.	Neural networks and fuzzy logic III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
29.	Stochastic Exploitation Models III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
30.	Computer Simulation III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
31.	Database Systems III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
32.	ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
33.	Decision support systems III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
34.	Artificial Intelligence III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
35.	Theoretical foundations of computer science III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
36.	Graph and Network Theory III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
37.	Project and Process Management III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*
38.	Complex Data Structures III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05,D_U07,D_K01,D_K03*

Annex V.3

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: civil engineering and transport

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Spatial analysis	20	2	*D_W02,_W03,D_U02. D_K05*
2.	Safety and reliability of building structures	20	2	*D_W03,D_W05,D_U02,D_K02*
3.	Digital Image Processing	20	2	*D_W01,D_U01,D_K01*
4.	Dynamic interaction of underground structures with the soil medium	20	2	*D_W02, D_U01, D_K05*
5.	Environmental physics	20	2	*D_W01,D_U04,D_K02*
6.	Photogrammetry	20	2	*D_W01,D_W02D_U01, D_U05, D_U10,,D_K03*
7.	Satellite photogrammetry	20	2	*D_W01,D_U04,D_K01*
8.	Identification of loads and structural systems	20	2	*D_W02, D_U02,D_K02*
9.	Geoinformatics infrastructures	20	2	*D_W01,D_U04,D_K04*
10.	Building Materials Engineering	20	2	*D_W04, D_U04, D_K02*
11.	Construction Project Engineering	20	2	*D_W01,D_U04,D_K05*
12.	Mechanics of the road substrate and airport	20	2	*D_W03,D_U02,,D_U04, D_K03*
13.	Methodology of geodesy and cartography	20	2	D_W04,D_U03,,D_K05
14.	Test Methods for Stiffness and Load-Bearing Capacity of Road and Airport Pavements	20	2	*D_W03,D_U07,D_K07*
15.	Numerical methods in geodesy	20	2	*D_W03, D_U04, D_K05*
16.	Design methods for folding bridge structures	20	2	*D_W03,D_U01,D_U03, D_K01,*
17.	Experiment Design Methods	20	2	*D_W02,D_U01, D_K01*
18.	Methods of parallel data processing	20	2	D_W04,D_U04,D_K03
19.	Spatial data modeling	20	2	*D_W05,D_U02,,D_U06, D_K05,*
20.	Modeling of road and airport pavement structures	20	2	*D_W01,D_W02,,D_U05, D_K01*
21.	Modeling of thermal and humidity processes	20	2	*D_W03,D_U04,D_K03*
22.	Modeling the Behavior of Reinforced Concrete Elements and Structures	20	2	*D_W02, D_U01, D_K01*
23.	Geometric and Physical Nonlinearities in Structural Mechanics	20	2	*D_W03, D_U04, D_K05*
24.	Explosive effects on defensive structures	20	2	*D_W02, D_U01, D_K05*
25.	Satellite-based atmospheric systems	20	2	*D_W02,D_U04,D_K01*
26.	Specialized measurement methods in geodesy	20	2	*D_W03,D_U06,D_K08*
27.	Structure and dynamics of the globe	20	2	*D_W02,D_U02,D_K05*
28.	Scheduling and costing systems for construction works	20	2	*D_W06,D_U06,D_K08*
29.	Computer systems and programs in general construction	20	2	*D_W01,D_W02,D_W03,D_U06, D_K03,D_K05*
30.	Computer systems and programs in communication construction	20	2	*D_W01,D_W02,D_W03,D_U06, D_K03,D_K05*
31.	Spatial reference systems	20	2	*D_W02,D_W03,D_W04 D_U WAT02, D_U07, D_U08, D_K05*
32.	Satellite systems in Earth exploration	20	2	*D_W02,D_W03, D_UWAT02, D_U07, D_U08, D_K05*
33.	Modern remote sensing methods	20	2	*D_W01,D_U04,D_K01,D_K05*
34.	Advanced Methods of Equalization Accounting	20	2	*D_W02, D_U04,D_K05*
35.	Issues of design and construction of railway roads	20	2	*D_W03, D_U05,D_K02*

Annex V.4

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: materials engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Structural studies by X-ray diffraction	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U13, D_K01, D_K04, D_K09*
2.	Structural studies by scanning microscopy	20	2	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*
3.	Mechanical Properties Testing of Engineering Plastics	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U13, D_K01, D_K04, D_K09*
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	20	2	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	20	2	*D_W01, D_W04, D_U05, D_K03*
6.	Semiconductor materials for optoelectronic applications	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*
7.	Nano and ultra-crystalline construction materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*
8.	Nanoporous anodic aluminum oxide: synthesis, design and applications	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U13, D_K01, D_K03, D_K05*
9.	Non-telecommunications applications of fiber optics	20	2	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*
10.	Final acceptance of machine and plant parts using coordinate measuring techniques, tactile profilometry and reverse engineering methods	20	2	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*
11.	Experiment planning and data analysis using Origin and Statistica	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*
12.	Basic properties of liquid crystals	20	2	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*
13.	Keysight Vee and Lab View for Data Control and Processing	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*
14.	Designing technological processes for incremental Direct Deposition methods	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
15.	Dielectric spectroscopy	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*
16.	Structural Determinants of Material Properties	20	2	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*
17.	Modern methods of material characterization	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*
18.	Contemporary information imaging systems and directions of their development	20	2	*D_W01, D_W06, D_U01, D_U02, D_U05, D_K03, D_K04*
19.	High-energy ball milling and mechanical synthesis	20	2	*D_W01, D_W01, D_U05, D_K03*
20.	Advanced materials for hydrogen storage	20	2	*D_W01, D_W03, D_U01, D_K04*
21.	Basics of plasmonics and metamaterials	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*
22.	Optoelectronic Imaging and Information Processing Techniques	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*

Annex V.5

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: mechanical engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	FEM Analysis in Load-Bearing Structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
2.	Numerical analyses of fracture mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
3.	Autonomy of mobile robots	30	3	*D_U04, D_W03, D_K01*
4.	Experimental tests of motor vehicles	30	3	*D_W04, D_U04, D_U05*
5.	Biomechanics of human body movement during a road accident	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
6.	Biofuels	30	3	*D_W01, D_W02, D_U05, D_K01, D_K03, D_K04*
7.	Construction and operation of industrial robots	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*
8.	Digital signal processing	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*
9.	Design of experiment	30	3	*D_W04, D_U04, , D_K04,*
10.	Dynamics of mechatronic system design	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*
11.	Dynamics of car movement	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*
12.	Dynamics of hydrostatic systems	30	3	*D_U04, D_W04, D_K01*
13.	Dynamics of multi-member systems	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
14.	Solid collision dynamics	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
15.	Environmentally friendly operating fluids	30	3	*D_W01, D_U05, D_K01, D_K04*
16.	Elements of advanced mechanics and discrete modeling in the construction and operation of machines	30	3	*D_W03, D_W04, D_U01, D_U05, D_U06, D_K04*
17.	Impulse loads of motor vehicles – selected issues	20	2	*D_W04, D_U04, D_K09*
18.	Technical Safety Engineering	30	3	*D_W03, D_U05, D_U07, D_K05*
19.	Computer-aided operation of machines	20	2	*D_W02, D_U05, D_K05*
20.	Shaping a safe car body	20	2	*D_W01, D_U04, D_K01, D_K05*
21.	Shaping the reliability of machines	30	3	*D_W01, D_U04, D_K01, D_K05*
22.	Composite materials in mechanical engineering	30	3	*D_W01, D_W01, D_U04, D_K01, D_K05*
23.	Mechanics of continuous media 1	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03*
24.	Mechanics of continuous media 2	30	3	*_W01, D_W02, D_W03, D_U05, D_K01, D_K03*
25.	Finite Element Method	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
26.	Methods of analysis of numerical experimental research results	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
27.	Methods of testing the condition of machines	30	3	*D_W03, D_U05, D_K01, D_K03*
28.	Test methods for air filters of internal combustion engines	30	3	*D_W04, D_U WAT02, D_U07, D_U12, D_K02*
29.	Experimental methods for investigating the thermophysical properties of solids	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*
30.	Methods and techniques for testing the mechanical properties of materials	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*
31.	Identification and optimization methods	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*
32.	Numerical Methods in Engineering Applications	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
33.	Numerical Methods in Mechanical Engineering	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
34.	Methods for determining object coordinates	30	3	*D_W04, D_U WAT02, D_U07, D_U12, D_K02*
35.	Methods for designing and optimizing aircraft structures	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*
36.	Constitutive Models of Materials in FEM Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
37.	Modelling of heat transfer processes	30	3	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*
38.	Modeling hydraulic drive systems	30	3	*D_U04, D_W04, D_K01*
39.	Modeling and simulation of mechatronics issues	30	3	*D_W04, D_U04, D_K01*
40.	Modeling and simulation of thermomechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
41.	Modeling and simulation computer programs	20	2	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*
42.	Modeling and simulation of nonlinear mechanical problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
43.	Parametric modeling and structural optimization with FEM	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
44.	Modeling Connections of Thin-walled Structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
45.	Flow modeling	30	3	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*
46.	Modeling machine motion	20	2	*D_U04, D_W04, D_K01*
47.	Modeling composite structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
48.	Modeling of coupled (electrothermomechanical) problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
49.	Modeling of the Contact Phenomenon in Structural Mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
50.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	20	2	*D_U04, D_W03, D_K01*
51.	Renewable energy sources	30	3	*D_W06, D_U WAT02, D_K07*
52.	CAE Engineering Software	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
53.	Experiment planning and optimization of mechanical objects	30	3	*D_W04, D_U04, D_K05*
54.	Basics of road safety	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
55.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*
56.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*
57.	Fundamentals of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
58.	Basics of modeling and simulation of nonlinear mechanical problems	20	2	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
59.	Theoretical foundations of FEM	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
60.	Starting processes of internal combustion engines	30	3	*D_W04, D_U04, D_K01*
61.	Transformations of the quantum structure of matter as a source of energy	30	3	*D_W01, D_W02, D_W06, D_U05, D_K01, D_K03, D_K05*
62.	Predicting the off-road mobility of land platforms	30	3	*D_U04, D_W03, D_K01*
63.	Rheology of lubricating oils	30	3	*D_W01, D_W02, D_U05, D_K01, D_K03, D_K04*
64.	Mechatronic sensors	30	3	*D_W03, D_W04, D_U06, D_K01, D_K04*
65.	Simulation and visualization of system dynamics	30	3	*D_W03, D_W04, D_U01, D_K01, D_K03*
66.	Control systems in mechanical engineering	30	3	*D_U04, D_W03, D_K01*
67.	Development trends in automotive technology	20	2	*D_W01, D_W03, D_U04 D_K01, D_K05*
68.	Theory and organization of machine operation	30	3	*D_W04, D_U06, D_K03*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
69.	Theory of technical systems	30	3	*D_W01, D_W03, D_U01, D_K01, D_K03*
70.	Thermomechanics of materials and studies of thermophysical properties	30	3	*D_W03, D_W04, D_U01, D_K03*
71.	Tribology	30	3	*D_W03, D_U04, D_K05*
72.	Durability of aircraft structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
73.	Radioelectronic systems in radar systems	30	3	*D_W03, D_W05, D_U04, D_K04*
74.	Validation of numerical models	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
75.	Introduction to the equations of mathematical physics	30	3	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*
76.	Modern machine and vehicle drive systems	30	3	*D_W03, D_U04, D_K05*
77.	Selected Technological and Material Aspects of Powder Metallurgy	30	3	*D_W04, D_U02, D_K01*
78.	Selected methods and techniques of temperature measurement	30	3	*D_W03, D_W04, D_U04, D_K05*
79.	Selected problems of rocket technology	30	3	*D_W03, D_U04, D_K05*
80.	Selected problems of higher algebra	30	3	*D_W03, D_U04, D_K05*
81.	Selected issues of functional analysis	30	3	*D_W03, D_U04, D_K05*
82.	Selected issues of safety and ergonomics of vehicle crews	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
83.	Selected issues of structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
84.	Selected Issues of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
85.	Selected issues of active defence of military vehicles	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
86.	Selected issues of modern programming – introduction to modern programming languages	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
87.	Strength of adhesive joints	30	3	*D_W03, D_U04, D_K05*
88.	Fatigue Strength and Fracture Mechanics	30	3	*D_W01, D_W03, D_U04, D_K05*
89.	Fatigue strength and fracture mechanics of materials and structures	30	3	*D_W01, D_U04, D_K01*
90.	Advanced methods of manufacturing products from sintered powders	30	3	*D_W04, D_U04, D_K01*
91.	Advanced ballistics, modeling, and simulation	30	3	*D_W01, D_U04, D_K01*
92.	Advanced Mathematics	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
93.	Advanced Materials	30	3	*D_W01, D_W03, D_U01, D_K01*
94.	Advanced Material Modeling	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
95.	Advanced modeling in structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
96.	Advanced measurement systems	30	3	*D_W04, D_U04, D_K01*
97.	Application of experimental mechanics in scientific research 1	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
98.	Application of experimental mechanics in scientific research 2	40	4	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
99.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
100.	Material and structural fatigue	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*

Annex V.6

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: chemical sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Analysis of Chemical Warfare Agents	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*
2.	Chemistry and technology of liquid crystal materials	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*
3.	Chemistry and technology of high-energy materials	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*
4.	Electroanalysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
5.	Physics and chemistry of carbon materials	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*
6.	Physicochemical aspects of the explosion	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*
7.	History of chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
8.	Ionization methods in analytics	20	2	*D_W03, D_W04, D_UWAT02, D_K01*
9.	Methods for preparing samples for analysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
10.	Spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
11.	Latest trends in electrochemistry	20	2	*D_W01, D_W03, D_UWAT02, D_U03, D_K01*
12.	Modern nanoporous materials	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*
13.	Modern methods of synthesis of functional organic compounds	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*
14.	Signal Processing in Analytical Chemistry	20	2	*D_W03, D_W04, D_U05, D_K03*
15.	Synthesis of liquid crystals	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*
16.	Introduction to Spectroscopy	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
17.	Modern analytical chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
18.	Advanced pyrotechnics	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
19.	Application of gas chromatography in physicochemical studies	20	2	*D_W WAT01, D_W01, D_W02, D_U WAT01, D_U WAT02, D_K01, D_K03*

Annex V.7

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: security sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Social research in security sciences	20	2	*D_W WAT01; D_W01; D_W06; D_U03; D_K03*
2.	Information security	20	2	*D_W06; D_U01; D_K05*
3.	Evaluation of security system processes and designs	20	2	*D_W03; D_U04; D_K05*
4.	Geography, Geographic Information Systems in Crisis Management	20	2	*D_W03; D_U04; D_K05*
5.	Systems Research Methodology	20	2	*D_W02; D_W04; D_U01; D_U05: D_K01; D_K03*
6.	International Military Relations	20	2	*D_W02; D_U04; D_K05*
7.	Problems of the information society	20	2	*D_W02; D_U04; D_K05*
8.	Strategies and concepts of state security management	20	2	*D_W02; D_U04; D_K05*
9.	Security theory	20	2	*D_W02; D_W05; D_U01; D_K05*
10.	Modern information warfare	20	2	*D_W02; D_W05; D_U01; D_U04; D_K05*

Annex VI.1
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	Curriculum content
1.	Computer Network Administration	IP networks. Routing in IP networks. Basics of Windows administration. Fundamentals of Linux system administration. Configuration of network devices. Services in LAN networks. Services in TCP/IP networks. Computer network diagnostics. Access networks. Network service servers. Computer network security.
2.	Computer-aided analysis of experimental data	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of univariate and multivariate data, processing of multidimensional experimental results using linear transformations, problems of discrimination including linear and non-linearly separable problems using simple methods of producing separating hyperplanes, methods of minimum distance classification, nearest neighborhood, k-means and hierarchical grouping.
3.	Biology and biomedicine – modern research techniques	Familiarization with scientific terminology in biology and medical biology. Familiarization with the principles of good laboratory practice. Familiarization with the requirements for work safety in biological and biomedical laboratories; the degrees of airtightness of laboratories. Proteins: structure, methods of studying structure, protein crystallography. The code of life – nucleic acids: the structure of the gene and genome; discovering new genes. Molecular biology techniques: PCR and hybridization. Sequencing non-genomes, microarrays. Molecular databases, bioinformatics. Mammalian cells: methods for studying cell proliferation and viability. Cell isolation, cell line cultures, use in tissue engineering. Medical biotechnology: cloning and the use of RNA interference. Tissue engineering: extracellular matrix, tissue scaffolds and nanotechnology. Tissue regeneration - the use of stem cells. Biomaterials and Biocompatibility Testing. Medical microbiology: detection, identification and control of microorganisms; antibiotics. Interpretation of the results of own research and their discussion based on the literature.
4.	Digital Image Processing	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
5.	Optical Radiation Detectors	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, photodiodes p-n, pin, APD, with Schottky barrier, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages.
6.	Electromechanical energy and signal converters	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements
7.	English for electronics	Mathematical symbols and operations. Notion of a function. Differential and integral calculus. Geometry Series and sequences. V ector, matrix and sets calculus. Probability and mathematical statistics Uncertainties of measurements. Basic physical quantities and their units. Notion of a physical field Electric properties of media. Lasers and light properties. Theory of solids. Structure and constituents of an atom. Basics of quantum theory of an atom; wave function. Chemical elements

Lp.	Item Name	Curriculum content
		and molecules' formation. Types of chemical bonding. Basic chemical nomenclature of chemical substances. Elements of materials engineering. General physicochemical characteristics of matter. Mechanical, electric, magnetic and optical properties of a substance Classes of materials. Thin films deposition technologies.
8.	Laser Physics	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
9.	Physics of laser media	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction. Energy levels of transition group metal ions. Phenomena of energy transfer between ions in active media.
10.	Photovoltaics	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.
11.	Functionalised optoelectronic nanomaterials	Modern optoelectronic materials – introduction. The issue of functionalization in terms of increasing safety. Graphene - the production of properties. Carbon nanotubes – production and properties. Fullerenes – production and properties. Boron nitride production and properties. Methods of functioning of surface structures. Use core-shield systems. The role of nanomaterial geometry. Selection of composites for optoelectronic functioning. Spectroscopic methods for the study of optoelectronic nanostructures. Examples of functional solutions for special applications.
12.	Supercontinuum Radiation Generation	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
13.	Imaging Information Engineering	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging

Lp.	Item Name	Curriculum content
		technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality - key system components, application solutions.
14.	Encoding and recognition of radio transmissions	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
15.	Crystallography	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
16.	Laser absorption spectroscopy in gas sensors	Discussion of gas detection methods and definition of gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
17.	Laser-plasma X-ray and extreme ultraviolet (EUV) sources	The aim of the course is to learn about the methods of producing X-rays and extreme ultraviolet radiation (EUV), to learn the basics of laser-generated plasma physics and X-ray and EUV optics, to learn the principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), to learn examples of the use of these sources in science and modern technology.
18.	Lasers for medical applications	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications and the therapeutic and diagnostic effects obtained.
19.	Pico- and femtosecond lasers	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
20.	Fiber lasers	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber

Lp.	Item Name	Curriculum content
		amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals - selected issues.
21.	Mathematical models of the electromagnetic field	Mathematical differential relationships. Distribution. Orthogonal functions in electromagnetic applications. Wave propagation in materials and metamaterials. Analytical models for calculating the radiation field. Potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the far zone criterion for real antennas. Differential equations in electromagnetic problems. Computational electromagnetism - differential methods.
22.	Finite Element Method	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
23.	Methods of analysis and measurement of random signals	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
24.	Data mining methods and tools	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
25.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations - condition index. Gaussian method of numerical solving of a system of linear equations. Direct methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Numerical methods solving ordinary differential equations.
26.	Methods of logical synthesis	The following educational contents will be presented as part of the course: Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the

Lp.	Item Name	Curriculum content
		acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
27.	Surveying and optoelectronic measurements	General conditions for carrying out measurements. Optoelectronic measurement sensors basic technical and metrological parameters. Measurement of the power and energy of optical radiation. Testing of optical radiation power and energy meters. Laser distance and speed measurements. Measurement of wavelength and spectrum of optical radiation. Measurement of wavelength and spectrum of optical radiation. Measurements of polarization and coherence (degree of coherence) of laser radiation. Testing the resolving power of the monochromator, testing the spectrum of the selected laser. Lidars in research and their applications. Interferometric measurements. Optoelectronic measurement and recording systems.
28.	Modeling of physical phenomena and processes	Approximation (Linear Regression, Polynomial Mean Quadratic Approximation, Trigonometric Approximation, Fast Fourier Transform) Numerical Integration and Differentiation (Rectangular, Trapezoid, Simpson, Gaussian Quadrature). Ordinary differential equations (Euler's method, solution stability, Runge-Kutta method, systems of equations), laser modeling. Partial differential equations - Parabolic equations (Thermal conductivity – a simplified model of the interaction of laser radiation with matter), wave equation Numerical modeling of laser radiation diffraction in the paraxial approximation - a method of development into a number of eigenfunctions
29.	Nonlinear Laser Conversion	Elements of crystallography and crystal optics. Properties of uniaxial and diaxial crystals (KDP, LiJO3, LiNbO3, KTP, BBO, LBO etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector synchronizm. Generation 2□ and summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits.
30.	Scientific and engineering calculations	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
31.	Optoelectronics in safety systems	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.
32.	Laser optics	ABCD-2D and 4D methods in geometric and wave optics. Laser beam parameters and methods of their measurement. Gauss-Schell model of laser beam transformation in optical systems. Basics of coupling and shaping laser beams. Properties of the resonator and Fabry-Perot interferometer. Elements of the theory of resonators, mode structure of laser radiation. Thermo-optics components.
33.	Coherent Light Optics	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.

Lp.	Item Name	Curriculum content
34.	Plasma in science and technology	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
35.	Basics of remote research	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron Paramagnetic Resonance (EPR) Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.
36.	Designing safety systems	Security strategy and principles for creating technical protections. Discussion of normative principles. Defining a set of good industry practices. Determination of the scope of possible technical protection measures. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor applications. Characteristics of a set of protective devices for outdoor applications. Determination of working conditions and restrictions in this respect. Structure of the technical and detailed design. Discussion of individual scopes of the detailed technical design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Discussion of the principles of detailed design and cost estimation. Design study in the field of technical and detailed design. Discussion of the required resources to determine the basis for the implementation of the project. Threat analysis. The concept of technical protection of the security system. Discussion of the principles of conducting threat analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. A detailed discussion of possible attack scenarios and verification of the possibility of technical security against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Indication of specific ways of description and graphic representation of the technical design. Presentation of the method of organizing documentation. Discussion of exemplary technical designs of executive structures of critical infrastructure facilities. Documents related to the technical detailed design. A list of documents related to the technical design. Presentation of the principles of developing an investor's and "blind" cost estimate. Indication of the need to compile technical catalogues and technical data sheets of devices.
37.	Programmable and Purpose-Built Circuits	The aim of the course is to familiarize students with the technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). The lectures will discuss the principles of designing the topography of digital circuits, methods of distributing power and distribution of clock signals, I/O buffers, IP blocks and design tools. The discussed issues will be verified practically as part of laboratory exercises, during which students will develop digital circuits in the selected ASIC or FPGA technology. The main effect of education will be the acquisition of practical skills in designing integrated digital

Lp.	Item Name	Curriculum content
		circuits.
38.	Acoustic sensors	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
39.	Microwave sensors in radiolocation	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
40.	Selected problems of digital signal processing	
41.	Smart radio networks	Smart radio network concept. CR architectures. Semantic context of CR. Problems of teaching in the CR system. Dynamic spectrum management. Problems of reception in CR. Ad-hoc CR networks, collaborative MIMO. Standards for CR networks. Security problems in CR. Current research programs in the area of CR.
42.	Optical Spectroscopy for Life Sciences	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński diagram Spectroscopic arrangement – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
43.	Digital systems in optoelectronic devices	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
44.	Test and measurement systems in the test laboratory	Signal conditioning systems. Control and measurement systems. Measurement signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
45.	Fiber optic technology	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.
46.	Terahertz technique	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
47.	Information concealment technique (steganography)	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of

Lp.	Item Name	Curriculum content
		hiding data – cases and scenarios of action.
48.	Thin film technologies	Historical outline of the importance of thin layers. The issue of the top layer. Thin film theory. Theory of thin film growth. Anti-reflective coatings and laser mirrors. Dichroic mirrors. Thin film polarizers. Radiation dividers. Interference and absorption filters. Solar cells. Methods of designing and manufacturing thin films. The role of nanocomposite geometry in increasing the optoelectronic functionality of surface structures. Methods of testing the properties of thin films. Quality control of surfaces and thin-film coatings – standards. Examples of functional solutions for special applications.
49.	Thermal imaging and infrared technology	Application of thermal radiation polarization in thermal imaging. Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Thermal imaging systems supporting the landing of aircraft. Modern infrared sensors with shaped and programmable detection zones. Active thermal imaging, measurement capabilities and prospects for its application. Multiband pyrometry for underwater oil exploration.
50.	Optical Radiation Detection Systems	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
51.	Modern transducers measuring physical quantities	The concept of a measuring transducer. Classifications of measuring transducers. Static and dynamic properties of transducers. Resistance strain gauges. Condenser drivers. Piezoelectric transducers. Inductive transducers. Magnetoelastic transducers. Thermoelectric transducers. Pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic transducers. Acoustic electronic transducers. Photoacoustic and photonic transducers. Integrated transducers.
52.	Selected issues of the operation of anthropotechnical systems	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
53.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force. Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
54.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials. Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.
55.	Advanced microelectronics technologies	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy

Lp.	Item Name	Curriculum content
		structure of semiconductors.
56.	Selected issues of the operation of anthropotechnical systems	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
57.	Applications of lasers in technology	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: technical informatics and telecommunications

Lp.	Item Name	Curriculum content
1.	Quantum Algorithms III	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	Algorithm Analysis III	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	Analysis and synthesis of visual information III	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	ICT Systems Diagnostics III	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
5.	Efficiency of ICT systems III	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
6.	Elements of forecast theory III	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.
7.	Software Evaluation III	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation. Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability

Lp.	Item Name	Curriculum content
		models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
8.	Physical Foundations of Quantum Information III	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
9.	Computer Graphics III	Introduction to computer graphics, basic applications and issues. Digital image - sampling, quantization, image perception, color description, external devices. 2D graphics - raster primitives, transformations, matrix transformations. 2D graphics - special effects, morphing/warping, filtration, texture filtration. Introduction to 3D graphics - representation, transformations, basic shading algorithms, raytracing, radiosity.
10.	Software Quality Engineering III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
11.	Cryptology III	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
12.	Mathematical Methods of Decision Support III	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-making under uncertainty. Methods of determining the representation of sets of irreparable decisions. Methods for determining "approximate sets of optimal solutions". Examples of modeling decision support processes.
13.	Discrete Mathematics III	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers.

Lp.	Item Name	Curriculum content
		Break down the number into its components. Asymptotics. Creating functions. Asymptotic notations. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
14.	Generative and Aspectual Methods in Production. software III	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
15.	Numerical methods III	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
16.	Multi-Criteria Optimization Methods III	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
17.	Mathematical Modelling III	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin , maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of indistinguishability. Lower and upper approximation of the set. Approximation accuracy. Optimal decisions with approximate data knowledge. Decision boards. Deterministic and non-deterministic rules. Uncertain variables.
18.	Modeling and verification of ICT networks III	Basics of verification of ICT systems (ST) based on formal models: model verification, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with

Lp.	Item Name	Curriculum content
		time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-2, CPN Tools, UPPAAL.
19.	Modeling human-computer interaction III	Computer systems with a user – operator. User activity in the system and evaluation of the quality of operation. Modeling the user experience. GOMS modeling method. Keystroke-Level Model method. THERP method and other methods. A Markov model to assess the quality of user input. Semimarkian model for assessing the quality of user input. Analytical and simulation tools for quality modeling. Examples. Modeling the quality of user experience in systems with strong constraints. Problems with assessing the quality of user experience.
20.	Modeling Conflict Situations III	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
21.	Business Process Modeling, Simulation and Analysis III	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
22.	Software Reliability III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and programmatic methods of shaping reliability software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability indicators, finite error models, infinite error models. Models in the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1-1988, IEEE/ANSI Std 982.2-1988.
23.	Reliability of Systems III	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for renewable facilities with zero renewal. Reliability of renewable facilities with non-

Lp.	Item Name	Curriculum content
		zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of structures reliability. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
24.	Optimization III	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
25.	Probabilistic III	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.
26.	Stochastic Processes III	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
27.	Image Recognition and Processing III	Introduction to the issues of digital recognition and image processing. Basic problems related to digital image acquisition and how to solve them. Frequency methods in digital image processing. Basics of using transforms in digital image processing and analysis. Spatial methods in digital image processing. Improving the quality of images with the use of convolutional, ranking, logical filters - their advantages, disadvantages, ways of implementation. Introduction to digital image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Basic methods of image identification: classification in the space of features, structural method.
28.	Neural networks and fuzzy logic III	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
29.	Stochastic Exploitation Models III	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
30.	Computer Simulation III	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws

Lp.	Item Name	Curriculum content
		and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simulation systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
31.	Database Systems III	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
32.	ICT systems III	Route and link availability control in the LAN environment: LAN link availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol : the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Frame Relay protocol: Frame Relay protocol design features, - configuring the Frame Relay protocol, diagnosing and resolving problems resulting from protocol misconfiguration. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IPSec protocol, MPLS-based VPNs.
33.	Decision support systems III	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
34.	Artificial Intelligence III	Paradigms of artificial intelligence and areas of its applications, limitations of artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search, simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
35.	Theoretical foundations	Algorithmic theory of information. Accuracy and correctness of algorithms.

Lp.	Item Name	Curriculum content
	of computer science III	Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transformations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
36.	Graph and Network Theory III	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. Complex graph as a special type of graphs. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms. Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
37.	Project and Process Management III	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of projects and processes, planning the usability and functionality of project processes, planning the reliability of project activities, planning of control and verification of results, project risk management. Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time

Lp.	Item Name	Curriculum content
		evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the enterprise, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, management of communication in the project, methods and techniques of process improvement, models of process management development. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of the rhomboid model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
38.	Complex Data Structures III	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering and transport

Lp.	Item Name	Curriculum content
1.	Spatial analysis	The module presents the principles, methods and techniques of advanced spatial data analysis. Applications in geographic information systems, statistical approaches. Formal techniques for examining data in terms of topology for the purposes of administrative decisions.
2.	Safety and reliability of building structures	Knowledge in the field of safety and reliability of building structures. Classifications and principles of shaping load-bearing structures of buildings and conditions for assessing their safety. Ways of description and the distribution of the random variable. Reliability and damage intensity features. Methodology of conducting reliability tests, risk assessment, safety of use of buildings and the effectiveness of their operation.
3.	Digital Image Processing	A lecture that captures the fundamental problems of digital image processing. Digital image filtration. Colorimetry. Digital image acquisition systems.
4.	Dynamic interaction of underground structures with the soil medium	The module discusses methods of formulating computational models of the dynamics of structural elements and systems as well as the soil foundation center of the building. In modeling, special attention is paid to the wave nature of the physical phenomena under consideration. As a consequence, the assumptions of the Stress Wave Method are formulated. This method is proposed as a basic tool for building computational models of dynamic interaction of buildings with the ground. Modern means of destruction are taken into account as load generators.
5.	Environmental physics	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits.
6.	Photogrammetry	Fundamental problems of digital image processing. Digital image segmentation. Filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF.
7.	Satellite photogrammetry	The topics of the lectures include modern methods and instrumental solutions used to implement satellite imaging for research and application purposes, currently and in the future.
8.	Identification of loads and structural systems	The module deals with the identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of initiating reactions of supporting systems of objects revealed by static or dynamic displacements or vibration frequencies.
9.	Geoinformatics infrastructures	The concept of geoinformatic infrastructures with particular emphasis on informational, technological (IT), organizational, legal and economic aspects. Architecture of distributed systems. Web Services. Characteristics of existing solutions, including INSPIRE, geoportal.gov.pl. The role of metadata and directory services. Application interoperability and database orchestration.

Lp.	Item Name	Curriculum content
10.	Building Materials Engineering	Contemporary trends in the modification of building, construction and finishing materials. Technologies for the preparation, implementation and optimal procedures of building materials and products in construction conditions. Structure and material conditions of composites used in construction. The role of additives and admixtures.
11.	Construction Project Engineering	Organization of construction projects, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. General knowledge, skills and competences necessary to design construction projects and to make decisions determining the manner, time, costs, quality, requirements and location of the construction project. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
12.	Road and airport ground mechanics	Modeling of the soil medium as a continuous single-phase and three-phase medium depending on the type of soil – cohesive and non-cohesive. Stiffness and Bearing Capacity of Subsoil as a Problem of the Separated Area of Elastic Half-Space. Dynamic effects caused by moving loads.
13.	Methodology of geodesy and cartography	Development of geodesy and cartography in retrospective perspective; its main stimulators. The essence of geodesy and cartography as part of the scientific discipline of the scientific discipline "Civil engineering and transport. " The tasks of geodesy and cartography in the face of expectations from other disciplines and from the knowledge-based economy. The state of geodesy and cartography against the background of the general state of science and technology, in particular in the aspect of potential benefits resulting from the use of the achievements of electronics, computer science and information technologies. Factors stimulating the development of geodesy and cartography, e.g. formalism, standardization, time as a dimension equivalent to the dimensions of geodetic space. The key importance of geodesy and cartography in the creation – in the methodological, legal and technical sphere – of the spatial information infrastructure.
14.	Stiffness Test Methods and load-bearing capacity of road and airport surfaces	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
15.	Numerical methods in geodesy	The course concerns the practical use of numerical methods to solve scientific and technical problems (geodesy). It presents the ideas and concepts of numerical methods. It illustrates numerical algorithms. It contains elements of programming – calculation scripts. It illustrates the use of tool libraries of scripting languages such as "Matlab, Octave, Scilab".
16.	Design methods for folding bridge structures	Presentation of the structure of folding bridges with determination of their technical and operational parameters. Next, the theory of calculating folding bridges taking into account assembly clearances for objects in a static and dynamic system is presented. The module completes the development of a bridge crossing design from the folding bridge structure.
17.	Experiment Design Methods	The essence of experimental research. Electrofusion strain gauge. Measurement and analysis of measurement errors. Organization of the measurement path. Experimental methods of testing materials in simple stress states – tensile, compression, shear, bending, torsion test. Testing

Lp.	Item Name	Curriculum content
		of materials in complex stress states. Evaluation of rheological properties of materials - creep and relaxation. Optical test methods in mechanics – elastooptics, optical, grating and holographic interferometry.
18.	Methods of parallel data processing	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods, functions of the Parallel Computing module. Methods and functions of the MATLAB Distributed Computing Server Toolbox module.
19.	Spatial data modeling	Methods of design and implementation of spatial databases, with particular emphasis on the OGC methodology and ISO standards in the field of geographic information. Conceptual scheme and principles of application scheme construction, metadata, quality and quality assessment. UML and GML. Polish and international standards in the field of geographic information. Developing an application scheme using UML notation. GML language. Familiarization with the Polish metadata profile. Knowledge of creating a Polish metadata profile. Ability to create metadata for a geoinformation asset.
20.	Modeling road pavement structures and airport	Construction of road surface layers, selection of materials and rules for their use in road structures. Road construction technologies along with executive requirements and selection of equipment for geotechnical works in road construction.
21.	Modeling of thermal and humidity processes	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
22.	Modeling the Behavior of Reinforced Concrete Elements and Structures	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
23.	Geometric and Physical Nonlinearities in Structural Mechanics	Deformations of flaccid structures and bodies with low rigidity require the use of geometric relationships with linear and nonlinear terms. The consequences of such deformations are reflected in the equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.
24.	Explosive effects on defensive structures	The module considers the physics of phenomena generated by explosive charges and fuel-air mixtures. Then, the methods of determining the parameters of explosive loads are presented. The types of mechanisms destroying the load-bearing elements and structures of the building

Lp.	Item Name	Curriculum content
		generated by the considered loads are analyzed.
25.	Satellite-based atmospheric systems	On-board equipment of the new generation of meteorological satellites. Interpretation of satellite imagery. Cartographic projections of satellite imagery. Determination of vertical profiles of the atmosphere. Using satellite data to study: wind field, mesoscale convective systems, fogs and low clouds, snow and ice cover, precipitation, orographic and polar phenomena and climate change. Directions of development of meteorological satellite systems.
26.	Specialized measurement methods in geodesy	Characteristics of special measurements. The role of measurements in the modern world, Precise distance measurement systems using interference methods, Measuring stations for precise 3D measurements, Examples of the use of industrial measurement systems for determining direction, geometry control, assembly and alignment of multidimensional machines and objects.
27.	Structure and dynamics of the globe	The shape of the Earth's globe as a consequence of the rotational and rotational motion in the Solar System. Internal structure – shell, mantle, nucleus. Distract surfaces. Tectonic plates. Magnetic and gravitational field. Marine, lithospheric and atmospheric tides and their consequences on the dynamics of the Earth's globe. Coriolis force. Conservative forces. The forces of gravity and gravity.
28.	Scheduling and costing systems for construction works	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
29.	Computer systems and programs in communication construction	Types and capabilities of specialized software in the field of communication construction, including selected methods and IT techniques, principles of defining the scope and structure of communication investments, the essence and issues of BIM technology, numerical terrain modeling and numerical analyses and simulations of technical systems.
30.	Computer systems and programs in general construction	Modeling of thermal states of a building using analytical and numerical methods using advanced systems and computer programs. Numerical methods for solving thermal conduction equations for non-uniform partitions. Non-stationary heat flow in a building. Analysis of the dynamic response of selected structural elements of a building using the stress wave method taking into account damping. Calculation of deformations and strain of structural elements in the elastic and elastic-plastic range. Determination of dynamic parameters - periods of free vibrations and critical damping.
31.	Spatial reference systems	Reference system. Frames of reference. Coordinate systems. Celestial and terrestrial reference systems and their realizations. Consistency of reference frames – the common designation of terrestrial and celestial reference frames. Discussion of problems related to the implementation of reference systems.
32.	Satellite systems in Earth exploration	Non-navigational applications of GNSS systems: occultation, reflectometry and refractometry. Study of geospheres from the ceiling of satellite orbit: atmosphere, hydrosphere, cryosphere, Earth's magnetic field, changes in ocean level. Discussion of problems related to satellite Earth research.
33.	Modern remote sensing methods	Modern computer remote sensing systems. Unsupervised classification of multispectral imagery. Supervised classification of multispectral imagery. Feature classification of multispectral and hyperspectral imagery. Use image classification methods in terrain analysis. Testing of water, vegetation, urban areas. Thermal techniques and microwave.
34.	Advanced Methods of	Generalized alignment model: parameter estimation. Diagnosis of gross

Lp.	Item Name	Curriculum content
	Equalization Accounting	errors in observations. Modifications of alignment methods: for correlated geodetic observations, with the presence of systematic errors of measurements. Measures of accuracy in geodetic networks. Evaluation of alignment accuracy. Iterative alignment methods. Sequential alignment – Kalman filtration. Equalization models with constraints: defining computational reference systems, s-transformations. Free alignment (independent networks): algebra of generalized matrices, interpretation of the results of free alignment. Resistant free alignment. Methods of detecting coarse errors in geodetic networks. Alignment of geodetic networks resistant to coarse errors. Reliability of geodetic networks Basics of colocation according to least squares. Elements of network design and optimization.
35.	Issues of design and construction of railway roads	Basic issues of design and construction of railway roads in accordance with European regulations (EC and EP directives and European standards). Aspects of the design of geometric layouts of railway lines, dimensioning of track systems of stations and passenger stops, solutions for conventional railway track nodes, high-speed urban railway lines, as well as for high-speed lines. Design of passenger transport equipment, freight transport infrastructure, design, construction and basic issues of operation of railway sidings and intermodal infrastructure.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	Curriculum content
1.	Structural studies by X-ray diffraction	Familiarization with the basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	Structural studies by scanning microscopy	Teach the basic concepts used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Familiarize yourself with the preparation used in reflection and transmission electron microscopy. Selected methods of advanced microscopic research (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of images and breakthroughs).
3.	Mechanical Properties Testing of Engineering Plastics	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	The aim of this subject module is to familiarize PhD students with the physical basis of electro-optical effects in Liquid Crystals (CK). PhD students will learn: selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals. This module will enable you to observe and understand the operation of liquid crystal displays, light wave phase modulators, eye protection filters and equipment against harmful electromagnetic radiation, which are ubiquitous in our lives.
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	The course introduces the student to issues related to the study of materials (in particular materials for storing hydrogen in the solid phase) with the use of: differential calorimetry, thermogravimetry and analysis by volumetric methods. The following will be discussed: types of equipment used for these tests, the principle of its operation, calibration methods, good practices of use, advantages, advantages, capabilities and limitations. Students will be introduced to the basics of test result analysis, result correction and selection of test parameters to obtain the best results. Practical classes will be conducted using the above-mentioned research techniques in application to selected materials.
6.	Semiconductor materials for optoelectronic applications	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic

Lp.	Item Name	Curriculum content
		semiconductors).
7.	Nano and ultra-crystalline construction materials	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	Nanoporous anodic aluminum oxide: synthesis, design and applications	Lectures in the subject: "Nanoporous anodic aluminum oxide: synthesis, design and applications" will cover the following topics: - Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.); - Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electrochemical synthesis (temperature, voltage, time); - The process of self-organization of matrix pores into a hexagonal system; - Soft anodization; - Hard anodizing; - Pulsed anodization; - Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods); - Applications of anodic aluminum oxide matrix (biosensors, filters, opto-electronic components, tissue engineering, etc.); - New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	Non-telecommunications applications of fiber optics	A subject discussing the technique of interference (phase) fiber optic sensors. The course defines the correct terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the determination of the role of the transducer as well as the optical and electronic processing of the signal. Introduction to two methods of building point sensors and about the distributed detection field as well as issues related to the multiplication of point sensors. The course includes within the framework of demonstration laboratories with the basic elements of the fiber optic sensor system.
10.	Final acceptance of machine and plant parts using coordinate measuring techniques, tactile profilometry and reverse engineering methods	The use of coordinate measuring techniques, tactile profilometry and reverse engineering methods at various stages of the technological process. Metrological properties of coordinate measuring machines, tactile profilometers and reverse engineering devices. Preparation and use of a multi-sensor measuring machine, tactile profilometer and 3D scanner to carry out measurements as part of the final acceptance of machine and equipment parts. Analysis of the results obtained, estimation of measurement uncertainty, final conclusions
11.	Experiment planning and data analysis using Origin and Statistica	Most of the research techniques used today allow for a large amount of experimental data. However, the problem is their processing and further analysis. The use of appropriate computer programs can significantly facilitate and shorten this task. The same is true for planning an experiment. Knowledge of appropriate statistical methods can significantly reduce the number of experiments without compromising the quality of the results obtained. During the workshop, participants will be introduced to the possibilities offered by Origin and Statistica programs in the field of experiment planning and data analysis.
12.	Basic properties of liquid crystals	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical

Lp.	Item Name	Curriculum content
		properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	Keysight Vee and Lab View for Data Control and Processing	Getting to know the basics of programming in LabView, including mastering the logic of the so-called graphic language. Mastering basic programming structures such as sequential blocks, for loops, while structures, feedback, etc. Mastering the use of objects of various types (numeric, string, bool), including in the form of matrices and clusters. Mastering basic methods of data processing and transfer. Development of own program algorithm for controlling a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Familiarization with the basics of programming in Keysight Vee, including mastering the logic of the so-called graphic language. Mastering basic programming structures such as sequential blocks, loops, selection structures, conditional statements, etc. Mastering how to use objects of various types, including matrices and complex variables. Mastering basic methods of data processing and transfer. Getting to know the Keysight Vee – MS Excel cooperation. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	Designing technological processes for incremental Direct Deposition methods	Designing elements of machine parts and devices using solid and surface modeling, taking into account the specificity of 3D printing. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological process design - production of the target production series. Basics of regeneration of elements of machine parts and devices using the LENS technique.
15.	Dielectric spectroscopy	A course introducing dielectric spectroscopy (impedance spectroscopy / radio frequency spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics for the analysis of the properties of materials used in electronics. It presents electrical phenomena at the atomic, molecular and macroscopic (medium) levels. It presents the theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. It takes into account parasitic effects in impedance measurements. It familiarizes students with research equipment (impedance analyzers), experiments and analysis of experimental data in the context of the properties of various materials.
16.	Structural Determinants of Material Properties	A form of materials engineering workshops improving the professionalism of the approach to solving scientific problems in the area of materials and technology. Arrangement of seminar working discussions - lecture - (only) on request, on a selected topic. Improvement in terminology, methodology, critical reception of external data, critical evaluation of own results. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions – mainly and on the example of the needs of own doctoral projects. Discussion of legal conditions in the field of organization and financing of research, problems of scientific integrity and ethics of scientists.
17.	Modern methods of material characterization	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.

Lp.	Item Name	Curriculum content
18.	Contemporary information imaging systems and directions of their development	Modern imaging systems for direct observation: liquid crystal, organic LEDs, microleds, flexible and roll-up displays. Discussion of the effects and materials used. The level of solutions achieved, limitations resulting from the physics of effects, material possibilities, available technology. Projection systems used effects, solutions ranging from cinema systems through didactic systems to micro-projectors. Directions of development of displays and projection systems. Particular emphasis will be placed on combining knowledge about the physical effects used in the construction of displays, new materials (including nano- structures used in LCDs, OLEDs and microLEDs), and the possibilities of modern technology with compliance with environmental protection requirements.
19.	High-energy ball milling and mechanical synthesis	The course introduces the student to issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. The audience will be introduced to different types of ball mills, the principle of their operation, the possibilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.
20.	Advanced materials for hydrogen storage	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity hydrogen storage materials. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
21.	Basics of plasmonics and metamaterials	The course introduces basic definitions of plasmonics and metamaterials. The physical basics, the interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces are discussed. It presents the technological conditions for the implementation of one-, two- and three-dimensional metamaterial structures. The physical and technological requirements and limitations for different types of metamaterials are discussed, as well as the use of classical technologies for the production of nano- and metamaterials. The PhD student will learn about methods of simulation of the properties of selected metamaterial and plasmonic structures and methods of characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. The applications of metamaterial structures in photonic devices and the prospects for the development of nano- and metamaterials with particular emphasis on military applications will be discussed.
22.	Optoelectronic Imaging and Information Processing Techniques	The PhD student will learn about the issues of color vision, the perception of black-and-white and color information, and the human-display-imaging interdependence, display requirements, and ergonomics of various types of imagery. The physical and theoretical basis of the effects used in displays and their determinants will be presented. Active displays - fluorescent, plasma, electroluminescent, construction, characteristic parameters, purpose and passive displays - liquid crystal, electrophoretic, structure, parameters and conditions of applications will be discussed. A lot of space will be devoted to segmented and multiplex liquid crystal displays as well as active matrix controlled liquid crystal displays. Projection systems, large-format displays, purpose, advantages and disadvantages will be discussed. The PhD student will learn about organic and inorganic materials for displays and the characteristics of their properties and elements of display production technology and the characteristics of technological processes, methods of control and evaluation of display performance parameters. Methods of three-dimensional imagery, methods of implementation and application,

Lp.	Item Name	Curriculum content
		teleimmersion will be presented.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

Lp.	Item Name	Curriculum content
1.	FEM Analysis in Load-Bearing Structures	The course will discuss the theoretical foundations of numerical methods of analysis of load-bearing structures in the linear range (including multi-stage analyses), the strategy of computer simulation of FEM of two- and three-dimensional problems in the field of mechanics and strength of materials, and the methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphic preprocessors (mainly MSC. Patran). PhD students will independently build 2D and 3D models for analysis in the field of selected engineering issues, perform calculations with attention to the selection of optimal analysis parameters and assess the correctness of calculation results using analytical methods and available experimental test results, on the example of elements and subassemblies of load-bearing structures.
2.	Numerical analyses of fracture mechanics	The aim of the course is to provide a doctoral student with knowledge in the field of the theory of fracture mechanics and algorithms for solving problems of fracture mechanics through numerical calculations. The theoretical part covers the following issues: basics of fracture mechanics, stress intensity factor, strength criteria in fracture mechanics, numerical methods for determining the stress intensity factor, methodology of calculations. The laboratory aims to familiarize doctoral students with the possibility of using FEM software to analyze fracture mechanics problems.
3.	Autonomy of mobile robots	Basic terms and definitions of mobile robots. Basics of wheeled robot control. Navigation with markers in the robot's environment. Issues of navigation, self-localization, odometry in connection with the construction of the robot. Determining the position of the robot based on the map. Vision systems in mobile robotics.
4.	Experimental tests of motor vehicles	Identification of the research target, selection of the test method for the intended use of the results. Validation of research methods and procedures. Principles for demonstrating equivalence of methods. Vehicle approval test procedure. Selected methods of type-approval tests of vehicles and their components. Rules for the selection of measuring equipment. Principles of maintaining traceability during tests, calibration and testing of measuring equipment. Criteria for checking. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty. Analysis and presentation of research results. Assessment of the validity of the test, assessment of the usefulness of the results in the area regulated by law. Practical implementation of selected methods of testing vehicles and their components.
5.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of the human body model and experimental research.
6.	Biofuels	Definitions, types and generations of biofuels. Methods of producing biofuels of different generations. Functional properties of biofuels. Methods of testing biofuels. Development tendencies of biofuels in utility, economic and legal aspects.
7.	Construction and operation of industrial robots	The classes allow you to learn about the construction and principles of operation of industrial robots. Principles of robotization of production lines and environments and languages for programming industrial robots
8.	Digital signal	The course prepares students to formulate mathematical models of

Lp.	Item Name	Curriculum content
	processing	deterministic signals in digital systems. The lectures present the general principles of time-frequency analysis of digital signals, as well as algorithms and methods of their processing. A lot of emphasis is placed on the hardware implementation of selected algorithms in DSP signal processors.
9.	Design of experiment	The course covers the following issues: •Determined and randomized trial plans •Measure the position and dispersion of the measurement results •Assessment of the significance of the influence of input quantities on the output quantity •Define a function that approximates the object's function •Evaluate the adequacy of the feature and the significance of its coefficients •Experimental optimization
10.	Dynamics of mechatronic system design	The course allows you to learn about the issues of modeling mechatronic systems, including elements of motion and vibration analysis of linear systems with one and many degrees of freedom, elements of motion analysis of nonlinear mechatronic systems, stability testing of linear and nonlinear mechatronic systems, and provides basic information supported by examples on self-excited vibrations as well as basic methods of measuring vibrations of mechatronic systems
11.	Dynamics of car movement	Modeling the movement of the car. Analysis of the dynamics of rectilinear and curvilinear motion. Modeling the process of a car crashing into an obstacle. Analysis of car vibrations.
12.	Dynamics of hydrostatic systems	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis and its description.
13.	Dynamics of multi-member systems	The course will discuss the theoretical foundations of numerical methods, analysis with the use of rigid solids and the strategy of computer simulation of multibodies with the use of various algorithms for formulating equations of motion and their integration. Various multibody analysis software environments and examples in the field of mechanical engineering will be discussed. Methods of modeling mechanical structures using rigid solids in plane and spatial systems will be presented. PhD students will independently build planar and spatial models using various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected mechanical engineering issues. During the course, they will perform multi-variant numerical analyses with attention to the selection of optimal calculation parameters and assess the correctness of the results obtained using analytical and experimental methods.
14.	Solid collision dynamics	Equations of the dynamics of solid collision. Collision energy balance. Deformation and restitution. Modeling of post-collision motion of solids that are subject to deformation in the area of their contact. Biomechanical models for the analysis of shock loads.
15.	Environmentally friendly operating fluids	Harmful impact of operating fluids on the environment. The essence of biodegradation, ecotoxicity and bioaccumulation and methods of their testing in application to operating fluids. Ecolabeling as a tool in promoting the development of ecological operating fluids. Modern fuels, oils, greases and special liquids with low environmental harm. Production and use of ecological operating fluids in legal, technical, economic and functional aspects. Global trends in the production and use of ecological operating fluids.
16.	Elements of advanced mechanics and discrete modeling in the construction and	The item consists of two parts. Part A includes elements of advanced mechanics, paying attention to the basics of variational methods. Part B deals with discrete methods in mechanics, with particular emphasis on the finite element method (FEM). For the purposes of practical operation,

Lp.	Item Name	Curriculum content
	operation of machines	the basics of the MATLAB language with its Symbolic Math Toolbox library are discussed, and on the example of a flat truss, all the characteristics of a member (or beam) element necessary to solve problems in the area of statics, dynamics and initial stability are derived.
17.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
18.	Technical Safety Engineering	The subject matter of the course includes: basic concepts in the field of safety engineering (technical hazard, safety hazard, risk of negative impact, risk of damage; functional layout, safety system and rescue equipment of a technical facility); the basics of conducting analyses related to the safety of a technical facility and a qualitative and quantitative approach to technical safety (learning about selected methods and techniques of safety analysis). Functional safety. Issues related to the development and implementation of safety-related machine control systems. Mathematical modeling of security systems.
19.	Computer-aided operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
20.	Shaping a safe car body	Body construction – shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
21.	Shaping the reliability of machines	Selected elements of probabilism in machine reliability. Reliability models of facilities. Durability and wear of machine parts. Testing, evaluating and forecasting machine reliability. Methods to improve reliability. Reliability in normative documents.
22.	Composite materials in mechanical engineering	The subject matter of the course allows you to learn about the definition and classification of composite materials. It discusses the properties of composites and their components. It presents selected technologies for the production of composite materials. It introduces the types of research used in the experimental analysis of mechanical properties of composites. It presents the problems of metal-composite connections, as well as operational problems related to composites. It indicates the use of composite materials in technology. The practical element is the acquisition of the ability to perform a simple repair of the composite structure
23.	Mechanics of continuous media 1	The course prepares students to understand 0-n valence tensors determining scalar quantities, vector quantities and tensor quantities in the mechanics of continuous media. The basics of the theory of the material continuum are presented, including material fields, event space, dynamical processes, reference systems, coordinate systems, and the application of the material, spatial and frozen reference frame in the MOC. Elements of tensor calculus are given, including the most commonly used in mechanics of material bodies - simple and double tensor operations. The ability to use field theory operators in a space parameterized by a curvilinear system is discussed. The key issues of kinematics and deformation of deformable bodies as well as deformation and strain tensors are discussed. The principles of conservation in mechanics are discussed in detail - the balances of: mass, momentum, angular momentum, energy and stress tensor. The basic postulates and principles of invariance in the construction of constitutive equations are explained.
24.	Mechanics of	The course contains elements of basic and well-established knowledge

Lp.	Item Name	Curriculum content
	continuous media 2	about the most important groups of continuous media and their division depending on the behavior of the medium as a function of the value of external forces. Elements of thermodynamics, elastic isotropic, anisotropic and orthotropic media with elements of thermoelasticity and an introduction to the nonlinear theory of elasticity are discussed. Further contents of the course include an introduction to the theory of plasticity, elements of Newtonian and non-Newtonian fluid mechanics, the most important elements of knowledge about viscous materials, viscoelastic fluids and viscoelastic solids. The basic rheological properties of solids and strength hypotheses are also discussed. The course develops the ability to determine the relationships between stresses and strains for individual material groups of continuous media, the use of dimensionless and generalized spatial variables in applied mechanics and the formulation of systems of equations and boundary conditions for isotropic and anisotropic media with elements of thermoelastic interactions.
25.	Finite Element Method	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
26.	Methods of analysis of numerical experimental research results	On selected deterministic and stochastic examples, the research methodology will be presented that allows the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
27.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
28.	Test methods for air filters of internal combustion engines	Test methods for the characteristics of effectiveness, absorbency and flow resistance of air filters. Selection of test conditions for filter characteristics. Air filter test benches. Test benches with ejective dust extraction and the use of a particle counter. Test dusts and their characteristics. Methodology for determining the characteristics of efficiency, absorption and flow resistance of air filters by gravimetric method. Methodology for determining the aerodynamic characteristics of the filter. Influence of the technical condition of the air filter on flow resistance .
29.	Experimental methods for investigating the thermophysical properties of solids	The following issues are included in the course: thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
30.	Methods and techniques for testing the mechanical properties of materials	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring

Lp.	Item Name	Curriculum content
		deformations during strength tests. Methods of testing the mechanical properties of materials under shock loading conditions.
31.	Identification and optimization methods	The course prepares students to identify mathematical models of dynamical systems using identification methods. As part of the lectures, methods of identification are presented. In addition, the course prepares doctoral students to solve single- and multi-criteria optimization tasks on their own. As part of the lectures, optimization methods are presented. As part of the exercises, PhD students formulate mathematical models based on an identification experiment and solve selected optimization tasks.
32.	Numerical Methods in Engineering Applications	The course allows you to learn the concepts and basic methods of numerical calculations. In the practical scope, they allow for the development (improvement) of the ability to select appropriate methods of numerical analysis and the ability to design and build - program a computational algorithm
33.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
34.	Methods for determining object coordinates	General characteristics of echolocation systems. Tasks of echolocation systems: detection, location, parameter estimation, identification. Methods of detecting echolocation signals. Probability of detection and probability of false alarm. Methods of measuring distances and angles used in the location of objects. Range equation in radiolocation and hydrolocation. Object tracking - Klaman filter. Synthetic aperture echolocation systems.
35.	Methods for designing and optimizing aircraft structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission modeling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
36.	Constitutive Models of Materials in FEM Analysis	As part of the course, a mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. will be presented. Experiments to determine the parameters of the models will also be presented. As part of the exercises, numerical analyses will be carried out using the learned models of materials.
37.	Modeling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software

Lp.	Item Name	Curriculum content
38.	Modeling hydraulic drive systems	Modeling of hydrostatic drive assemblies, subassemblies, elements and systems. Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
39.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
40.	Modeling and simulation computer programs	Concepts and principles related to mathematical modeling and computer simulation. Formulate and transform models. Basic numerical procedures and their applications. Simulation software and programming in the Matlab-Simulink system.
41.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
42.	Modeling and simulation of thermomechanics	Description of issues related to the phenomena of heat energy exchange. Heat conduction and heat transfer. Constitutive equations taking into account the influence of temperature. Conjugate thermoelastic and thermoplastic issues. Thermoorthotropy.
43.	Parametric modeling and structural optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
44.	Modeling Connections of Thin-walled Structures	Overview of thin-walled structures. Materials used in thin-walled structures. Types of connections. Principles for designing selected types of connections, e.g. glue, rivet, screw. Introducing concentrated load into the structure. Modeling thin-walled structures including joints. Analysis of the strength of the selected connection of thin-walled structure elements.
45.	Flow modeling	The course prepares students to obtain well-founded knowledge in the field of the role of computer modeling methods of flow processes in basic and applied problems of fluid motion dynamics. Ability to formulate research projects using simulation methods of research on streamlined issues, consolidating competence in the field of transferring knowledge from the basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver are discussed. Problems of modeling flow turbulence are discussed, including averaged Navier-Stokes equations, turbulent stress tensor, possibilities and problems of modeling turbulence. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES) are discussed informatively. This allows to obtain initial skills in mapping complex objects of simulation research, construction and performing basic operations on computational meshes, analysing the reliability and accuracy of numerical modeling results
46.	Modeling machine motion	General principles of modeling mechanical, hydrostatic, electromechanical systems. Deterministic and random processes. Dynamics of systems with variable mass.
47.	Modeling composite structures	Introduction. The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.
48.	Modeling of coupled (electrothermomechanical) problems	The course will present the equations of the mathematical-physical model describing coupled phenomena, as well as the initial-boundary conditions taking into account the influence of various factors and phenomena (thermal, electrical, mechanical). Then, simplifications will be presented

Lp.	Item Name	Curriculum content
		that allow its solution using numerical methods. The presented model will be used to analyze thermo-electric and electrothermomechanical phenomena.
49.	Modeling of the Contact Phenomenon in Structural Mechanics	General division of contact phenomena. Mathematical foundations of the description and solution of the problem of contact. Algorithms for defining and solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
50.	Modern CAD\CAM\ design and manufacturing systems	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
51.	Renewable energy sources	The importance of energy in the development of modern civilization. Modern fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
52.	CAE Engineering Software	The aim of the course is to familiarize doctoral students with the CAE systems available on the market. The lectures will include an overview of this type of systems with an indication of their purpose and the possibility of use in structural analyses. In addition, doctoral students will learn about their philosophy of work. During laboratory exercises, doctoral students will learn how to independently prepare numerical models for calculations in the static and dynamic range. They will learn how to run calculations and how to present and process the obtained results.
53.	Experiment planning and optimization of mechanical objects	Optimize your experiment using experiment plans and statistical models. Factor plans. Optimization plans. Determined plans. Plans to be analyzed, composition – property. Analysis of the relevance and adequacy of statistical models. Methods of determining the extremum of statistical functions. Examples of the use of experiment optimization in mechanical engineering.
54.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Statistics of road accidents and their interpretation.
55.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
56.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.
57.	Fundamentals of Mechanics of Continuous Media	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.
58.	Basics of modeling and simulation of nonlinear	Numerical methods in the aspect of nonlinear analysis of complex problems in the field of statics. Numerical methods to describe the issue

Lp.	Item Name	Curriculum content
	mechanical problems	of interactions between bodies. FEM in complex problems of dynamic analysis of a system of bodies.
59.	Theoretical foundations of FEM	The classes are aimed at deepening knowledge about the finite element method. The lecture will discuss the principles of operation of the algorithms that make up the finite element method. Knowledge of these algorithms is essential to properly use FEM for custom tasks and to know and understand the method's limitations and sources of error. Laboratory classes will consist in implementing the knowledge gained during the lecture in FEM calculations. Thanks to the ability to create your own procedures, the user can influence the course of FEM calculations at various stages.
60.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.
61.	Transformations of the quantum structure of matter as a source of energy	Transformation of the quantum structure of matter as a common source of energy released in the processes of fusion and fission of atomic nuclei, during combustion, explosion and detonation. Modern explosives and rocket fuels, interpretation and modeling of transformation processes. Issues of operation of machinery and equipment containing or in contact with hazardous materials.
62.	Predicting the off-road mobility of land platforms	NG NRMM (New Generation NATO Reference Mobility Model) tools that allow to predict the vehicle's ability to move in specific/difficult terrain conditions. The course will include techniques and technologies, methodologies and tools for determining the chemical, physical and mechanical properties of soil, testing soil as a deformable substrate on which land platforms move, but also treated as a mined medium. The curriculum content will include the results of scientific work on soil modeling and interactions between the ground and the general driving system.
63.	Rheology of lubricating oils	Basics of rheology of viscous liquids. Rheological properties of engine and gear oils and their characteristics. Methods of testing the rheological properties of lubricating oils. Selection of oils in terms of their functionality and minimization of friction resistance. Changes in the rheological properties of engine, gear and hydraulic oils during use and the factors determining them.
64.	Mechatronic sensors	The course prepares students to formulate mathematical models of mechatronic sensors. The lectures present the general principles of mechatronic sensors. The method of measurement, errors and methods of calibration of sensors are discussed. As part of the exercises, PhD students formulate mathematical models of mechatronic sensors. They carry out measurements and determine faults using technologically advanced mechatronic sensors.
65.	Simulation and visualization of system dynamics	The course prepares doctoral students for research using simulation and visualization of the dynamics of mechanical systems. For selected mathematical models of dynamical processes that require the solution of systems of ordinary differential equations. The lectures present general principles for solving the problems of simulation and visualization of dynamics. As part of the exercises, doctoral students simulate the dynamics of systems for selected mathematical models, and in some of the exercises also computer animation.
66.	Control systems in mechanical engineering	Fuzzy logic Hardware configuration of PLCs. Simple logic control tasks IEC 61131-3 – programming languages. Synthesis of the process and control algorithm of the SFC method. GPS control systems
67.	Development trends in	Problems of the development of automotive technology and road traffic.

Lp.	Item Name	Curriculum content
	automotive technology	Concepts of intelligent transport systems. Development tendencies in the construction of drive and chassis systems. Discussion of selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs). Car occupant safety system and driver assistance systems. Development of vehicle lighting systems. Hybrid, electric, autonomous cars.
68.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
69.	Theory of technical systems	The subject matter of the course includes: basic concepts of the theory of technical systems and general principles of construction and design of technical systems, thermodynamic and informational description of the state of the system, energy and information circulation, estimation of entropy of the system state, energy flow in technical devices, examples of hardware and software solutions of devices
70.	Thermomechanics of materials and studies of thermophysical properties	The aim of the course is to familiarize participants with the phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and to present selected issues of the statistical description of these phenomena to explain the nature of thermo-physical properties. This will allow you to understand the phenomena of heat transfer in materials and material structures and will enable you to learn about the methodology of thermophysical research and methods of thermal analysis.
71.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.
72.	Durability of aircraft structures	The aim of the course is to provide the doctoral student with knowledge on the methods of determining and testing the durability of aircraft. The theoretical part covers the following issues: concepts of aircraft operation, factors limiting the durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in aircraft operation. The laboratory aims to familiarize doctoral students with selected non-destructive testing techniques, strain gauge measurements and computer calculations of fatigue cycles.
73.	Radioelectronic systems in radar systems	General characteristics of echolocation systems. Tasks of echolocation systems: detection, location, parameter estimation, identification. Methods of detecting echolocation signals. Probability of detection and probability of false alarm. Methods of measuring distances and angles used in the location of objects. Range equation in radar. Object tracking - Kalman filter. Synthetic Aperture Echolocation Systems
74.	Validation of numerical models	Discussion of simulation methods in structural mechanics. Principles of building numerical models of a selected physical process. Verification vs. validation. Planning a numerical experiment in the context of its correctness. Conclusions from numerical validation studies.

Lp.	Item Name	Curriculum content
75.	Introduction to the equations of mathematical physics	The course prepares students to formulate mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. The lectures present general principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics is presented. The method of reducing borderline issues to a dimensionless form is discussed. As part of the exercises, doctoral students formulate mathematical models based on mathematical physics equations. The seminar is devoted to the presentation by PhD students of the results of projects involving the formulation of mathematical models based on mathematical physics equations
76.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
77.	Selected Technological and Material Aspects of Powder Metallurgy	The course prepares for the implementation of research work in which there is scientific research related to powder metallurgy (MP). The lectures present basic knowledge about sinter technology. The phases of processes (MP), their main parameters and their impact on the final properties of the products are discussed. The starting materials used in the technology and their morphological and granulometric characteristics are presented. New varieties of powder metallurgy processes are discussed, i.e. mechanical alloying and production of nanopowders, as well as examples of the application of powder metallurgy in technology. As part of laboratory exercises, doctoral students learn about the methods of determining selected granulometric parameters of powders and how to perform them and interpret the results obtained.
78.	Selected methods and techniques of temperature measurement	The course prepares students for the correct performance of temperature measurements associated with conducting experimental research. The lectures present the theoretical foundations of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. In particular, the following types of thermometers are discussed: liquid thermometers, thermoelectric thermometers, resistance thermometers, thermistor, quartz, bimetallic, radiation, fiber optic thermometers and thermal imaging cameras. As part of laboratory exercises, doctoral students use the knowledge gained during lectures to independently perform temperature measurements using thermocouples, resistance temperature sensors and a thermal imaging camera. Particular emphasis is placed on the statistical processing of the measurement results
79.	Selected problems of rocket technology	The course prepares students to formulate mathematical models of physical processes related to the dynamics of rocket motion. The lectures present the general principles of rocket construction. The construction of rocket compartments along with mathematical models is discussed. As part of the exercises, doctoral students formulate mathematical models and conduct computer simulation and visualization of the rocket flight path. They determine the overloads of the rockets on the flight path.
80.	Selected problems of higher algebra	The course is used to learn the concepts and theorems of algebra relating to basic algebraic structures, vector spaces and linear operators, as well as quadratic and quadric forms, as well as to understand and master transformations related to changes in bases in vector spaces and

Lp.	Item Name	Curriculum content
		projections to subspaces in Euclidean spaces.
81.	Selected issues of functional analysis	The course is used to develop the ability to create mathematical models and to pose simple and inverse problems of mathematical physics in variational or optimization forms, and to learn methods of approximate solving of such correctly and incorrectly posed problems.
82.	Selected issues of safety and ergonomics of vehicle crews	Contemporary threats of military vehicles. Standards and regulations for vehicle crew survival – parameters. Propagation of pressure pulses. Numerical methods used to assess the safety of vehicles and their crews.
83.	Selected issues of structural dynamics	Analysis of the pressure impulse load on the structure. Verification of FEM results analytically. Approximate methods for the evaluation of the results obtained.
84.	Selected Issues of Mechanics of Continuous Media	Elements of thermomechanics, elastic waves in continuous media, shock waves, explosion mechanics.
85.	Selected issues of active defence of military vehicles	The course will present the requirements for modern, complex systems on the example of an active vehicle defense system. Physical phenomena used in this type of interdisciplinary systems will be discussed, with particular emphasis on the mechanical part of the systems in question. Experimental studies of materials and methods of their modeling, as well as studies of the entire system will be presented. Methods of modeling selected effectors will be discussed.
86.	Selected issues of modern programming	Introduction to the object-oriented programming paradigm. Intermediate code and runtime issues. Introduction to C# and Microsoft Visual Studio. Create console programs using C# and Microsoft Visual Studio. Introduction to Python. Creating programs based on selected algorithms.
87.	Strength of adhesive joints	Mechanical and physical properties of macromolecular plastics. Theories of adhesion. Technologies for constituting adhesive bonds. Analysis of the strength of adhesive joints. Strength optimization of adhesive joints
88.	Strength of adhesive joints	Mechanical and physical properties of macromolecular plastics. Theories of adhesion. Technologies for constituting adhesive bonds. Analysis of the strength of adhesive joints. Strength optimization of adhesive joints.
89.	Fatigue Strength and Fracture Mechanics	General characteristics of fracture mechanics. Griffith's theory of brittle fracture, elements of linear fracture mechanics. Ductility in the fracture zone. Force fracture criterion. Material fatigue phenomenon. Strength and fatigue life, Wöhler, Smith, Haigh charts. Propagation of fatigue cracks. Modeling of cracks and determination of the quantities determining their development. Calculation of fatigue life based on fracture velocity. Probabilistic Methods of Fatigue Calculations
90.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Application of the principles of fatigue strength of materials and fracture mechanics in the operation of structures. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Fatigue test methodologies and fatigue testing equipment.
91.	Advanced methods of manufacturing products from sintered powders	The subject matter of the course allows you to learn about the processes of manufacturing machine parts using modern methods of manufacturing engineering, including powder metallurgy.
92.	Advanced ballistics, modeling, and simulation	During the course, students will learn about the methods of analysis, research and modeling of advanced ballistics phenomena and use practically learned modeling methods to analyze selected phenomena of internal, external or final ballistics.
93.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and

Lp.	Item Name	Curriculum content
		strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
94.	Advanced Materials	The subject matter of the course allows you to learn about the structure, properties and technology of obtaining semiconductors (silicon, GaAs, blue optoelectronics nitrides, silicon carbide, solid solutions with HgCdTe, graphene) and low-dimensional quantum structures used in the construction of photonic sensors of the optical range. The presented examples of applications of these materials are the most spectacular achievements of sensor technology in the military, industrial equipment, security systems and medicine. The part of the course covering construction materials concerns the properties of classic superalloys and intermetals and selected special alloys such as: ADI cast iron, steel (duplex and maraging), as well as ceramic and composite materials as well as diffusion and adhesive surface layers modified by thermo-chemical treatment and produced by CVD and PVD methods, by ion implantation and thermal spraying with supersonic metallization flux flow. It determines the knowledge of the basics of the structure of these materials, the ability to analyze the structure and mechanisms of phase transitions, as well as the ability to make structural changes and assess their performance based on the technological processes of their production. It introduces the types of research used in the experimental analysis of structure and mechanical properties. It indicates the use of engineering materials of special importance in technology. The practical element is the acquisition of the ability to assess the use of a given type of material with specific properties in engineering design.
95.	Advanced Material Modeling	Modern ceramics, ceramic composites, residual stress problem, gradient materials, modeling of material structures, statistical analysis of FEM calculation results.
96.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
97.	Advanced measurement systems	The course allows you to learn about the structure and organization of computer-controlled measurement systems as well as the procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. In practical terms, they allow you to master the basics of programming and how to use virtual instruments to collect, collect and process measurement data.
98.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
99.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
100.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	The course will present issues related to the propagation of waves (elastic, plastic). A mathematical description will be presented to analyze the presented issue, as well as boundary conditions. Then, methods to solve the presented issue will be briefly characterized. On selected examples, the analysis of wave propagation will be shown.
101.	Material and structural fatigue	The classes are aimed at providing the doctoral student with knowledge in the field of material fatigue and teaching the practical use of tools for computer-aided analysis. The theoretical part covers the following issues:

Lp.	Item Name	Curriculum content
		basics of fatigue of materials, low- and high-cycle fatigue, S-N curve, hypotheses of fatigue damage accumulation, correction of average stresses, analysis of load spectra, planning and conducting fatigue tests. The exercises will cover the practical elements of durability analysis, which can be performed using simple analytical calculations. The laboratory aims to familiarize doctoral students with engineering software enabling fatigue analyses.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

Lp.	Item Name	Curriculum content
1.	Analysis of Chemical Warfare Agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and technology of liquid crystal materials	The subject covers the molecular structure, structure and texture of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and technology of high-energy materials	The course includes the presentation of the current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels. Lectures and laboratory classes concern in particular: (i) structural determinants of the stability and sensitivity of explosive compounds; (ii) design, fabrication and characterisation of nanostructured explosive mixtures; (iii) principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; (iv) new ways of producing explosive compositions and forming them into charges; (v) design, manufacture and characterisation of thermobaric explosives; (vi) design, synthesis and explosive properties of complex compounds; (vii) design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids, and (viii) new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Electroanalysis	Basics and classification of electrochemical methods of analysis. Potentometry. Electrogravimetry. Coulometry. Polarography. Volammetry. Conductometry. Amperometric titration. Capillary electromigration techniques - apparatus for capillary electrophoresis and the principle of separation of mixture components. Capillary isotachophoresis (CITP). Micellar Electrokinetic Chromatography (MEKC). Capillary gel electrophoresis (CGE). Capillary Isoelectric Focusing (CIEF). Capillary electrochromatography (CEC). Overview of the application of electrochemical methods in practice.
5.	Physics and chemistry of carbon materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and bioactivity of carbon materials. Prospects for the development of new carbon

Lp.	Item Name	Curriculum content
		structures and their applications.
6.	Physicochemical aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
7.	History of chemistry	The students will be introduced to the broadly understood roots of modern chemistry. At the beginning, the synthesis of elements in the universe will be discussed, followed by the first observations and chemical achievements of antiquity (alchemy). The history of chemical discoveries in the world will be presented chronologically, taking into account the contemporary division of scientific fields such as physical chemistry, analytical chemistry, chemical analysis, organic synthesis, food chemistry. Particular emphasis will be placed on the achievements of chemistry after 1661 (R. Boyl). The development of techniques for separation of substances and analysis and their impact on the development of views on chemistry and the structure of chemical compounds will be presented. The evolution of nomenclature and symbols of elements and chemical compounds will be discussed. The history of the periodic table of Mendeleev, kinetic and thermodynamic studies will be presented. Particular emphasis will be placed on the rapid development of organic chemistry and synthesis in the 20th century and its impact on the emergence of molecular biology.
8.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
9.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
10.	Spectroscopic methods	Expanding the knowledge on spectroscopic methods for PhD students in the discipline of chemical sciences. Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Modern spectroscopic methods.
11.	Latest trends in	Modern models of the double electrical layer (EDL). Voltammetric

Lp.	Item Name	Curriculum content
	electrochemistry	techniques. Currently used materials and designs of working electrodes. Electrochemical Impedance Spectroscopy (EIS) and its applications. New fuel cell designs, biofuel cells, coal-powered cells, construction. New electrocatalytic circuits, applications. The latest types of lithium-ion batteries. Lithium-sulfur batteries. Application of intercalation in electrochemistry. Electrochemical capacitors (EDLC), construction. Ionic liquids (ILs). Application of carbon materials in electrochemistry. Electrochemical methods for surface modification of solids. Electropolymerization. Conductive polymers.
12.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Adsorption of nitrogen and argon as a complete method for determining the specific surface area, porosity and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and investigation of adsorption properties of graphene composite materials. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
13.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals – introduction, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials
14.	Signal Processing in Analytical Chemistry	Basic methods of processing the analytical signal. Spectra obtained from measuring instruments used in analytics. Big data processing. Multivariate data obtained from combined measurement techniques. Search for analytical information contained in large data sets. Elements of chemometrics. Principal components method. Similarity analysis. Presentation of measurement data in scientific publications.
15.	Synthesis of liquid crystals	Introduction to liquid crystals, structure and anisotropic properties. Applications of liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Super fluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
16.	Introduction to Spectroscopy	Basic knowledge of spectroscopic methods for PhDs in disciplines other than chemical sciences. Two versions of the item are possible. Standard version: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Individual version in accordance with the interests of the PhD student, extending selected spectroscopic methods from the given group of methods: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). Oscillation-rotational and rotational spectroscopy. One-dimensional and two-dimensional nuclear magnetic resonance (NMR)

Lp.	Item Name	Curriculum content
		spectroscopy. Circular dichroism spectroscopy (ECD and VCD). Mass spectrometry (MS).
17.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
18.	Advanced pyrotechnics	The students will be familiarized with the latest solutions used in military and civilian pyrotechnics. Contemporary reducers, oxidants, binders and modifiers will be discussed. Pyrotechnic applications of high-nitrogen compounds will be presented. Modern compositions of curtain smoke active in the infrared range will be discussed. Students will be introduced to modern multi-base solid rocket fuels. The solutions used in airbag inflators will be discussed. Prospective applications of pyrotechnic mixtures in medicine will be presented. The basic algorithms used in the modeling of combustion processes and analytical optimization of the composition of pyrotechnic compositions will be discussed.
19.	Application of gas chromatography in physicochemical studies	The essence of interactions in chromatography. Mechanisms of chromatographing test substances. Basic chromatographic quantities. State functions – methods of calculation and interpretation. Study of the physical transformations of pure substances. Phase stability and phase transitions. Study of surface properties and basic surface phenomena. Methods of surface determination and analysis.

Annex VI.7
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security sciences

Lp.	Item Name	Curriculum content
1.	Social research in security sciences	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Desk *research.*
2.	Information security	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPuugula, Biba, Clark-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
3.	Evaluation of security system processes and designs	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
4.	Geography, Geospatial Information Systems in Crisis Management	Identification of the needs of geoanalyses in the CMS. The essence of GIS systems. Functional components of GIS systems. Feature geospatial attribute location and description systems. Mechanisms for imaging and visualization of objects. Comprehensive monitoring of facilities and threats in the CMS. Threat analysis models and tools from a geospatial perspective.
5.	Systems Research Methodology	The genesis of holistic-systemic concepts. Evolution of the holistic-systemic paradigm. Applications of systems analysis, RAND experience. Evaluation of dual-use technologies. Modeling of security systems
6.	International Military Relations	International systems, world history, and the theory of military relations (presentism, ahistoricism, Eurocentrism, anarchophilia, state-centrism, alternative). Systems thinking about international military relations (ability to interact, process, structure). Analysis levels and dimensions. Military-political trials. Ability to interact in the modern international system. Perspectives – a post-modern system of international military relations.
7.	Problems of the information society	Information civilization, information culture, information society. Models of development and constitutive features of the information society. Security of the cyberspace of the state. The information society as a risk society.
8.	Strategies and concepts of state security management	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal-functional factors and ways of defining security in doctrines and strategies (comparative analysis).
9.	Security theory	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies "Old" and "new" wars in the interpretations of realism and constructivism.
10.	Modern information warfare	Evolution of conflicts. Technical determinants, technological revolutions and their impact on the wars of the postmodern world (infowar, net war,

Lp.	Item Name	Curriculum content
		cyberwar). Information warfare in the doctrines of selected countries, comparative analysis. Information warfare scenarios, risk analysis. Future studies: models, forecasts

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology

No. 24/WAT/2023 of 23 February 2023

amending the resolution on the establishment of the "Curriculum of education at the Doctoral School of the Military University of Technology"

Pursuant to § 21(1)(21) of the Statute of the Jarosław Dąbrowski Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is hereby resolved:

§ 1

The following changes are made to the Curriculum of the Doctoral School of the Military University of Technology, which is an annex to the Resolution of the Senate of the Military University of Technology No. 36/WAT/2019 of 30 May 2019 on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology":

1) the words *'automation, electronics and electrical engineering'* are replaced by the words *'automation, electronics, electrical engineering and space technologies'*;
2) the words *"civil engineering and transport"* shall be replaced by the words *"civil engineering, surveying and transport".*

§ 2

The resolution enters into force on the day of its adoption, with effect from 11 November 2022.

President of the Senate

/--/ Brig. Gen. Prof. Przemysław Wachulak

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 124/WAT/2020 of 27 February 2020

on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology"

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85), in conjunction with § 21(1)(21) of the Statute of the Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019. on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of October 9, 2019), the following is resolved:

§ 1

The *Education Program at the Doctoral School of the Military University of Technology is established,* which is attached to the resolution.

§ 2

The curriculum referred to in § 1 is in force from the academic year 2020/2021.

§ 3

Doctoral students of the Doctoral School of the Military University of Technology who started their education in the academic year 2019/2020 may update their Individual Education Programmes on the basis of this programme.

§ 4

The resolution shall enter into force on the date of its adoption.

President of the Senate

Brig. Gen. Tadeusz SZCZUREK, PhD, DSc, Eng.

Attachment to the Resolution of the Senate of the Military University of Technology No. ...../WAT/2020 of 2020

CURRICULUM

AT THE DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

I. General principles

1. The curriculum at the Doctoral School of the Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics and electrical engineering** - a field of engineering and technical sciences;
    2) **technical informatics and telecommunications** - a field of engineering and technical sciences;
    3) **civil engineering and transport** - a field of engineering and technical sciences;
    4) **materials engineering** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security sciences** - a field of social sciences;
    7) **Chemical sciences** - a field of exact and natural sciences.

2. The learning outcomes take into account the requirements specified for level 8 of the Polish Qualifications Framework.

3. Number of semesters: **8**

4. Number of ECTS credits – min. **30 points**

5. The number of compulsory courses is 100 hours and 20 hours of practical training carried out in the form of conducting classes or participating in them and corresponds to a total of 10 ECTS credits, and the number of optional courses is at least 200 hours and corresponds to at least 20 ECTS credits**.** Optional courses may include classes in subjects carried out at the Military University of Technology from the optional module, optional subjects carried out at another university or a domestic or foreign research institution, and other forms of education, e.g. apprenticeships, internships in and outside the Military University of Technology, in particular at another university or domestic or foreign scientific institution.

6. Language of instruction: **Polish or English –** only in the case of subjects, internships or other forms of education indicated in the Individualized Education Program (IPK).

7. The program is valid from: **academic year 2020/2021**

8. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:

    Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is the professional preparation of future staff in the fields of engineering and technology, exact and natural sciences and social sciences, in particular in the field of military technology and security technology. The task of the Doctoral School is to provide doctoral students with the latest knowledge, shape skills and improve competences at the

highest level, as well as cultivate patriotic traditions and responsibility for the Homeland in broadly understood aspects, both military and civilian, in accordance with the principle "Omnia Pro Patria" – "Everything for the Homeland". The activities of the Doctoral School correlate with the strategic objectives of the Academy's development in terms of strengthening the position of the Military University of Technology in the system of Polish and European higher education, including as the leading educational pillar of higher military education and the expert and research base of the Ministry of National Defence, as well as other ministries. In addition, it emphasizes the elite nature of the Academy as a university conducting innovative teaching and scientific activities, also developing international cooperation in this field.

9. Prerequisites for the candidate for the Doctoral School

   The candidate should have qualifications at level 7 of the Polish Qualifications Framework (Master's degree, Master's degree in engineering or equivalent) and have completed a Master's degree in a field related to the scientific discipline conducted at the Doctoral School. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may admit a person who is a graduate of first-cycle studies or a student who has completed the third year of uniform master's degree studies. Detailed requirements are set out in the rules of recruitment to the Doctoral School established by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for subjects for which the university learning outcomes are required;
2) in the code column - reference of the assumed learning outcome to the appropriate code of the component of the description of the first- and second-cycle characteristics of learning outcomes at level 8 of the Polish Qualifications Framework (PQF 8).

Effect number symbols	Expected learning outcomes	code description component
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_W P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
Skills: the graduate is able to		
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8U_U P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8U_U P8S_UW*
D_U03	*independently plan and act for their own development and inspire and organize the development of others,*	*P8U_U P8S_UU*
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: − define the purpose and object of scientific research, formulate a research hypothesis, − develop research methods, techniques and tools and apply them creatively, − draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8U_U P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8U_U P8S_UK*
D_U10	*participate in scientific discourse, exchange of experiences and ideas, also in the international environment*	*P8U_U P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*

Effect number symbols	Expected learning outcomes	code description component
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*
D_U13	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*

	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_K* *P8U_KK*
D_K02	*taking into account the challenges in the professional and public sphere, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_K* *P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8U_K* *P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8U_U* *P8S_KK*
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8U_U* *P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8U_U* *P8S_KO*
D_K07	*initiating activities in the public interest*	*P8U_U* *P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8U_U* *P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including:* *− conducting scientific activity in an independent manner,* *− respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8U_U* *P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- completion of courses included in the curriculum, including the Individual Education Program (IPK);
- credit for professional practice
- credit for other forms of education, if they are included in the IPK;
- completion of a doctoral seminar at which the doctoral student presents an analysis of the research area to which he or she is to devote his/her research and reports from this seminar;
- edited doctoral dissertation.

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.
2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.
3. The curriculum includes at least 300 hours of classes and min. 20 hours of professional internships carried out in the form of conducting classes or participating in their conduct - at least 30 ECTS credits in total.
4. The curriculum consists of:

1) the basic module for all scientific disciplines conducted at the Doctoral School, in the amount of 100 hours with a total of 9 ECTS credits;
2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned, subject to sections 6 and 7;
3) from 20 to 180 hours of professional internships in the form of teaching or participation in conducting classes from the third semester of education – max. 60 hours per year (in accordance with an individual education program), which are assigned 1 ECTS credit.
4) optionally other forms of education on a full-time basis and the number of ECTS credits specified in an individualised learning programme.

5. A doctoral student is required to complete the basic module and 20 hours of professional practice in the form of conducting classes or participating in them. A doctoral student, in consultation with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. It is allowed for courses to come from different scientific disciplines and to be taught at another university or research institution.
6. In the case of planned implementation of other forms of education (e.g. internship, internship at and outside the Military University of Technology), the supervisor determines the number of ECTS points credited to the doctoral student as part of the optional module, not exceeding 5 points per semester of the internship or internship, and the expected learning outcomes. In this case, the number of hours of classes in the optional module cannot be less than 100 hours.
7. The implementation of the education programme, taking into account the provisions of paragraphs 5 and 6, should ensure that the candidate achieves the assumed learning outcomes specified in Chapter II.
8. By the end of the first semester of education, the doctoral student submits to the director of the Doctoral School, agreed with the supervisor, an individual education program in the field of the optional module.
9. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year.
10. Classes in the subjects of the optional module, if the number of doctoral students enrolled in a given course is less than 5, are planned on an individual basis according to individual curricula.
11. Classes are held in accordance with the education plan (general and individual) and are carried out according to the semester timetables in force at the Academy.

V. Modules of the curriculum

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, compulsory for doctoral students of all disciplines (I-II sem.)				
1.	Higher education	20	1	D_WWAT01, D_W05, D_W06, D_UWAT01, D_U03, D_K01, D_K02
2.	Principles of conducting classes and self-presentation techniques	10	1	D_WWAT01, D_UWAT01, D_U03, D_U13, D_K01, D_K06
3.	The process of applying for research funding	10	1	D_K01, D_K03.D_K04
4.	Organizational, legal and ethical aspects of scientific work	10	1	D_W06, D_U12,
5.	Methodology of conducting scientific research	10	1	D_WAT02, D_U01-U05
6.	Ownership and commercialisation of research	10	1	D_W05, D_W06,D_U06
7.	Scientometrics and bibliometrics in scientific activity	4	1	D_W05, D_U08, D_K03, D_K04
8.	Principles of writing a scientific paper	6	1	D_W05, D_W06, D_U07
9.	Analysis of the research area - seminar	20	1	D_W01, D_W02, D_W03, D_W4, D_U08
Optional modules related to the scientific discipline (III-VIII sem.) *:				
1	Automation, Electronics & Electrical Engineering	min. 200 hrs*	min. 20 points*	*Annex V.1 - page 12*
2	Informatics and Telecommunications			*Appendix V.2 – p. 14*
3	Civil Engineering and Transportation			*Annex V.3 – page 16*
4	Materials Science			*Annex V.4 – p. 17*
5	Mechanical Engineering			*Annex V.5 – page 18*
6	Chemical Sciences			*Annex V.6 – p. 21*
7	Security Sciences			*Appendix V.7 – p. 22*
Internships at WAT (III-VII sem.) - in accordance with the individual education program				
1	in the form of conducting classes or participating in conducting them	20-180 hours	1	*D_WWAT01, D_UWAT01 D_K01*
Other forms of education (III-VII sem.) * - according to the individual education program				
1	e.g. internships, internships carried out in and outside the Military University of Technology at another university or scientific institution in Poland or abroad	*The number of hours, ECTS credits and reference to learning outcomes is determined by the supervisor in an individualised learning programme*		

Remark:

a detailed list of subjects of optional modules is presented in Annexes V.1 to V.7

**Min. the number of hours in the Optional Module may be reduced by the implementation of other forms of education, the sum of ECTS credits for the Optional Module and other forms of education may not be less than 20 points.*

VI. Framework Programme

The framework programme includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

Lp.	Course/Module Name	Curriculum content/notes
Basic module, compulsory for all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Principles of teaching and technology self-presentation	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	Process Inference for financing Research	Classes devoted to the processes of applying for funding of basic scientific research and research related to statutory activities, financing of domestic and foreign scientific internships, addressed especially to young scientists at the beginning of their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Science and Higher Education, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Organizational, legal and ethical aspects of work Scientific	The Law on Higher Education and Science (Constitution of Science). Organization of research activities at the university on the example of the Military University of Technology. A model of scientific career in Poland. Parametric evaluation of an academic teacher and a research unit (discipline). Foreign internships and scholarships as part of a scientific career. Formal and substantive activities for the implementation of the doctoral dissertation. Principles of ethics in scientific research and in scientific careers.
5.	Methodology of conducting scientific research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that needs to be solved – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6.	Proprietary Rights and commercialization Research	The curriculum provides doctoral students with basic information on the methods of intellectual property protection (in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection). During the course, the issues of commercialization of the results of scientific research and development work will also be discussed.
7.	Scientometrics I Bibliometrics in the activity Scientific	Classes devoted to scientometric and bibliometric indicators used in international bibliographic databases (Scopus, WoS), as well as national ministerial requirements related to the evaluation of researchers. Dissemination of scientific activities and research results, with particular emphasis on open access policy. The use of bibliographic databases and e-sources in scientific research. Tools supporting the collection of materials supporting the writing of scientific papers.
8.	Principles of writing a scientific paper	The Law on Higher Education and Science (Constitution of Science). types of doctoral dissertations, requirements for doctoral dissertations, structure of a doctoral

Lp.	Course/Module Name	Curriculum content/notes
		dissertation, edition of a doctoral dissertation, examples of doctoral dissertations, examples of reviews of doctoral dissertations.
9.	Area Analysis Research	Seminar classes, during which the doctoral student presents the area of knowledge to which he or she is to devote his or her research, the current state of knowledge in this area. Presents a draft schedule for the implementation of the research project in order to collect comments, suggestions and make corrections. Together with the supervisor, he develops an individual education program.
Optional modules related to the scientific discipline:		
1	Automation, Electronics & Electrical Engineering	*Annex VI.1 – page 23*
2	Computer science technical and telecommunications	*Annex VI.2 – page 30*
3	Civil Engineering and Transportation	*Annex VI.3 – page 38*
4	Engineering Material	*Annex VI.4 – page 42*
5	Engineering Mechanical	*Annex VI.5 – page 46*
6	Chemical Sciences	*Annex VI.6 – page 57*
7	Science Safety	*Annex VI.7 – page 60*

Note: *a detailed list of subjects of optional modules and their curricular content is presented in Annexes VI.1-VI.7*

VII. Organisation of apprenticeships and other forms of education

Apprenticeships are carried out in the form of teaching classes or participation in their conduct. From the third to the seventh semester of education, a doctoral student is obliged to conduct classes or participate in conducting them for a minimum of 20 hours.

In special and justified cases (e.g. disability of a doctoral student), the supervisor may exempt the doctoral student from the obligation to undergo professional practice. An ECTS credit for practical placements should be obtained through additional optional subjects or other forms of education.

Other forms of education are allowed from the third to the seventh semester of education, i.e. internships (other than teaching classes or participation in their conduct), internships in and outside the Military University of Technology, m.in. at a university, a domestic or foreign scientific institution, enterprises whose scope of activity is related to the subject of the doctoral dissertation. Other forms of education, their number of hours and the allocation of ECTS credits are decided by the supervisor in the Individualised Education Programme.

Apprenticeships and other forms of education are credited towards a descriptive grade (*zal / nzal*) in the academic year in which they took place. Credit for professional practice carried out in the form of teaching classes or participation in them

is made by the head of the unit in which the internship was carried out. In other cases, the credit is made by the supervisor or the director.

VIII. Educational plan

The education plan consists of a general part for all doctoral students of the year, and an individual education plan for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

An individual education plan is created for each doctoral student who, in consultation with the supervisor from the optional module for the scientific discipline (or from others), selects the courses to be implemented. Selected classes will be planned from the third to the sixth semester, it is recommended that the semester workload of the doctoral student should be even - at the level of 5 ECTS points.

Wojskowa Akademia Techniczna

PLAN KSZTAŁCENIA W SZKOLE DOKTORSKIEJ

WSZYSTKIE DYSCYPLINY NAUKOWE PROWADZONE W SZKOLE DOKTORSKIEJ

	moduły/*przedmioty*	ogółem godzin/ pkt ECTS		liczba godzin/pkt ECTS w semestrze:															
				I		II		III		IV		V		VI		VII		VIII	
		godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS
Moduł podstawowy, obowiązkowy dla wszystkich dyscyplin		**100**	**9**	**50**	**3**	**50**	**6**												
1	Dydaktyka szkoły wyższej	**20**	**1**	**20**	**1**														
2	Zasady prowadzenia zajęć dydaktycznych i techniki autoprezentacji	**10**	**1**	**10**	**1**														
3	Proces wnioskowania o finansowanie badań naukowych	**10**	**1**			**10**	**1**												
4	Organizacyjne, prawne i etyczne aspekty pracy naukowej	**10**	**1**			**10**	**1**												
5	Metodologia prowadzenia badań naukowych	**10**	**1**			**10**	**1**												
6	Prawa własności komercjalizacja badań naukowych	**10**	**1**			**10**	**1**												
7	Zasady pisania pracy naukowej	**6**	**1**			**6**	**1**												
8	Naukometria i bibliometria w działalności naukowej	**4**	**1**			**4**	**1**												
8	Analiza obszaru badawczego	**20**	**1**	**20**	**1**														
Moduły fakultatywne związane z dyscypliną naukową:																			
1	**Automatyka, elektronika i elektrotechnika**	**min. 200 godz.***	**min. 20 pkt ECTS***					**Zgodnie z Indywidualnym Programem Kształcenia (IPK) liczba godzin zajęć co najmniej 200 godz.* i min. 20 pkt ECTS***												
2	**Informatyka techniczna i telekomunikacja**																		
3	**Inżynieria lądowa i transport**																		
4	**Inżynieria materiałowa**																		
5	**Inżynieria mechaniczna**																		
6	**Nauki o bezpieczeństwie**																		
7	**Nauki chemiczne**																		
Praktyki zawodowe - zgodnie z IPK																			
1	*wformie prowadzenia zajęć lub uczestnictwa*	**20-180**	**1**					**Zgodnie z Indywidualnym Programem Kształcenia (IPK) liczba godzin od 20 do180 godzin i 1 pkt ECTS**											
Inne formy kształcenia* - zgodnie z indywidualnym programem kształcenia																			
1	*np. praktyki, staże realizowane wi poza WAT, winnej uczelni lub instytucji naukowej krajowej lub zagranicznej*	***zgodnie z IPK****						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											

** min. liczba godzin w Module fakultatywnym może być zmniejszona poprzez realizację innych form kształcenia, suma punktów ECTS za moduł fakultatywny i inne formy kształcenia nie może być mniejsza niż 20 pkt.*

Note: *the number of apprenticeships carried out from the third semester onwards in the form of teaching classes or participation in them is at least 20 hours and may not exceed 60 hours per year.*

IX. Internal system for ensuring the quality of education at the Doctoral School

The internal education quality assurance system at the Doctoral School is an element of the Education Quality Assurance System at the Military University of Technology.

As part of the preparation of doctoral students for high-level research work, the importance of continuous monitoring and systematic improvement of the quality of their education increases. The education quality policy, resulting from the mission and development strategy of the Academy, is implemented at the Academy by setting

appropriate goals and quality standards, as well as by implementing, continuously monitoring and improving the internal quality assurance system.

The scope of the internal education quality assurance system at the Doctoral School includes in particular:

1) monitoring and analysis of the formal and legal side of the teaching process;
2) periodic review and updating of education programs;
4) analysis of the conditions for the implementation of the teaching process;
5) monitoring factors affecting the quality of education;
6) analysis of the functioning and development of methods for improving the quality of education.

Annex V.1

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Administration of computer networks II	20	3	*D_W03*
2.	Computer-aided analysis of experimental data	30	3	*D_W03, D_U06*
3.	Digital Image Processing	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
4.	Optical Radiation Detectors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
5.	Electromechanical energy and signal converters	30	3	*D_W01, D_U05*
6.	English for electronics	20	2	*D_W03, D_U04, D_K01*
7.	Laser Physics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
8.	Physics of laser media	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
9.	Photovoltaics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
10.	Functionalised optoelectronic nanomaterials	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
11.	Supercontinuum Radiation Generation	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
12.	Imaging Information Engineering	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
13.	Encoding and recognition of radio transmissions	30	3	*D_U05*
14.	Crystallography	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
15.	Laser absorption spectroscopy in gas sensors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
16.	Laser-plasma X-ray and extreme ultraviolet (EUV) sources	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
17.	Lasers for medical applications	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
18.	Pico- and femtosecond lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
19.	Fiber lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
20.	Mathematical models of the electromagnetic field	20	2	*D_W02, D_W03*
21.	Finite Element Method	30	3	*D_W02, D_W03*
22.	Methods of analysis and measurement of random signals	30	3	*D_W02, D_U05*
23.	Data mining methods and tools	30	3	*D_W02, D_W04*
24.	Numerical methods	30	3	*D_W01, D_W03*
25.	Methods of logical synthesis	30	3	*D_W02, D_W03*
26.	Surveying and optoelectronic measurements	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
27.	Modeling of physical phenomena and processes	30	2	*D_W01, D_W02, D_W03 D_U04, D_K03, D_K05*
28.	Nonlinear Laser Conversion	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
29.	Scientific and engineering calculations	30	3	*D_W04*
30.	Optoelectronics in safety systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
31.	Laser optics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
32.	Coherent Light Optics	30	2	*D_W01, D_W02, D_W03*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
				D_U010, D_K03, D_K05
33.	Plasma in science and technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
34.	Remote Sensing Basics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
35.	Designing safety systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
36.	Programmable and Purpose-Built Circuits	30	3	*D_W01, D_U05*
37.	Selected problems of digital signal processing	30	3	*D_W01, D_W03*
38.	Acoustic sensors	20	2	*D_W04, D_W05*
39.	Microwave sensors in radiolocation	20	2	*D_W02, D_U04*
40.	Smart radio networks	30	3	*D_W01, D_W03*
41.	Optical Spectroscopy for Life Sciences	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
42.	Digital systems in optoelectronic devices	30	2	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*
43.	Test and measurement systems in the test laboratory	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
44.	Fiber optic technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
45.	Terahertz technique	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
46.	Information Concealment Technique	30	3	*D_W01, D_W02, D_U05*
47.	Thin film technologies	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
48.	Thermal imaging and infrared technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
49.	Optical Radiation Detection Systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
50.	Modern transducers measuring physical quantities	30	3	*D_W01, D_U05*
51.	Selected issues of the operation of anthropotechnical systems	30	3	*D_W08, D_U05 i 06*
52.	Selected issues of vibration theory	20	2	*D_W02*
53.	Selected issues of modern programming – introduction to modern programming languages	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
54.	Selected issues in acoustoelectronics	30	3	*D_W04, D_W05*
55.	Advanced microelectronics technologies	30	3	*D_W01, D_U05*
56.	Applications of lasers in technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*

Annex V.2

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: technical informatics and telecommunications

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Quantum Algorithms III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
2.	Algorithm Analysis III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
3.	Analysis and synthesis of visual information III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
4.	ICT Systems Diagnostics III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
5.	Efficiency of ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
6.	Elements of forecast theory III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
7.	Software Evaluation III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
8.	Physical Foundations of Quantum Information III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
9.	Computer Graphics III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
10.	Software Quality Engineering III	20	2	*D_W01,D_W02,D_W03,D_U01 ,D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
11.	Cryptology III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
12.	Mathematical Methods of Decision Support III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
13.	Discrete Mathematics III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
14.	Generative and Aspective Methods in Software Development III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
15.	Numerical methods III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
16.	Multi-Criteria Optimization Methods III	20	2	*D_W01,D_W02,D_W03,D_U01 ,D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
17.	Mathematical Modelling III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
18.	Modeling and verification of ICT networks III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
19.	Modeling human-computer interaction III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
20.	Modeling Conflict Situations III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
21.	Business Process Modeling, Simulation and Analysis III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
22.	Software Reliability III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
23.	Reliability of Systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
24.	Optimization III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
25.	Probabilistic III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
26.	Stochastic Processes III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
27.	Image Recognition and Processing III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
28.	Neural networks and fuzzy logic III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
29.	Stochastic Exploitation Models III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
30.	Computer Simulation III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
31.	Database Systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
32.	ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
33.	Decision support systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
34.	Artificial Intelligence III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
35.	Theoretical foundations of computer science III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
36.	Graph and Network Theory III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
37.	Project and Process Management III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
38.	Complex Data Structures III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*

Annex V.3

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: civil engineering and transport

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Safety and reliability of building structures	20	3	*D_W03; D_W05; D_U02; D_K02*
2.	Dynamic interaction of building structures with a soil medium	20	2	*D_W02; D_U01; D_K05*
3.	Environmental physics	20	2	*D_W03; D_U04; D_K02*
4.	Modeling of thermal and humidity processes	20	2	*D_W03; D_U04; D_K03*
5.	Identification of loads and structural systems	20	2	*D_W02; D_U02; D_K02*
6.	Investment process in the construction industry	20	2	*D_W01; D_U04; D_K05*
7.	Mechanics of road and airport runway soil foundations	20	3	*D_W03; D_U02; D_U04; D_K03*
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	20	2	*D_W03; D_U07; D_K07*
9.	Design methods for folding bridge structures	20	2	*D_W03; D_U01; D_U03; D_K01*
10.	Design methods of the experiment	20	3	*D_W02; D_U01; D_K01*
11.	Modeling the behavior of elements and structures reinforced concrete	20	2	*D_W02; D_U01; D_K01*
12.	Geometric and physical nonlinearities in mechanics Design	20	2	*D_W03; D_U04; D_K05*
13.	Explosive effects on defensive structures	20	2	*D_W02; D_U01; D_K05*
14.	Scheduling and costing systems for construction works	20	2	*D_W06; D_U06; D_K08*
15.	Engineering of building materials	20	3	*D_W04, D_U04, D_K05*
16.	Cartographic methods of research	20	2	*D_W02, D_U05, D_U07, D_K03, D_K05*
17.	Spatial data exploration	20	2	*D_W02, D_W04, D_UWAT02, D_U01, D_U05, D_K03, D_K05*
18.	Data science in geospatial research	20	2	*D_W02,D_W03,D_UWAT02, D_U01, D_U05, D_K03, D_K04*
19.	Advanced methods of photogrammetric studies	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
20.	Programming in spatial information systems	20	2	*D_W02, D_W05, D_U06, D_U10, D_K03, D_K06*
21.	Reference systems in geosciences	20	3	*D_W02,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*
22.	Global Geodetic Observing System	20	3	*D_W01,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*
23.	Modern photogrammetric techniques	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
24.	Selected numerical methods in geodesy	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
25.	Methods of parallel data processing	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
26.	Mathematical foundations of digital image processing	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
27.	Numerical methods with linear algebra	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
28.	Time series analysis in geodesy	20	3	*DW_03,DW_04,DW_05 D_UWAT02,D_U01,D_U02,D_U03,D_U04,D_U05,D_U07,D_U08,D_U010,D_U012,D_K03,D_K04,*

Annex V.4

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: materials engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Structural studies by X-ray diffraction	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*
2.	Structural studies by scanning microscopy	20	2	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*
3.	Mechanical Properties Testing of Engineering Plastics	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	20	2	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	20	2	*D_W01, D_W04, D_U05, D_K03*
6.	Semiconductor materials for optoelectronic applications	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*
7.	Nano and ultra-crystalline construction materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*
8.	Nanoporous anodic aluminum oxide: synthesis, design and applications	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U03, D_K01, D_K03, D_K05*
9.	Non-telecommunications applications of fiber optics	20	2	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*
10.	Final acceptance of machine and plant parts using coordinate measuring techniques, tactile profilometry and reverse engineering methods	20	2	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*
11.	Experiment planning and data analysis using Origin and Statistica	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*
12.	Basic properties of liquid crystals	20	2	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*
13.	Keysight Vee and Lab View for Data Control and Processing	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*
14.	Designing technological processes for incremental Direct Deposition methods	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
15.	Dielectric spectroscopy	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*
16.	Structural Determinants of Material Properties	20	2	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*
17.	Modern methods of material characterization	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*
18.	Contemporary information imaging systems and directions of their development	20	2	*D_W01, D_W06, D_U01, D_U02, D_U05, D_K03, D_K04*
19.	High-energy ball milling and mechanical synthesis	20	2	*D_W01, D_W01, D_U05, D_K03*
20.	Advanced materials for hydrogen storage	20	2	*D_W01, D_W03, D_U01, D_K04*
21.	Basics of plasmonics and metamaterials	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*
22.	Optoelectronic Imaging and Information Processing Techniques	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*

Annex V.5

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: mechanical engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	FEM Analysis in Load-Bearing Structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
2.	Numerical analyses of fracture mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
3.	Autonomy of mobile robots	30	3	*D_U04, D_W03, D_K01*
4.	Experimental tests of motor vehicles	30	3	*D_W04, D_U04, D_U05*
5.	Biomechanics of human body movement during a road accident	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
6.	Biofuels	30	3	*D_W01, D_W02, D_U05, D_K01, D_K03, D_K04*
7.	Construction and operation of industrial robots	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*
8.	Digital signal processing	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*
9.	Design of experiment	30	3	*D_W04, D_U04, , D_K04,*
10.	Dynamics of mechatronic system design	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*
11.	Dynamics of car movement	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*
12.	Dynamics of hydrostatic systems	30	3	*D_U04, D_W04, D_K01*
13.	Dynamics of multi-member systems	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
14.	Solid collision dynamics	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
15.	Environmentally friendly operating fluids	30	3	*D_W01, D_U05, D_K01, D_K04*
16.	Elements of advanced mechanics and discrete modeling in the construction and operation of machines	30	3	*D_W03, D_W04, D_U01, D_U05, D_U06, D_K04*
17.	Impulse loads of motor vehicles – selected issues	20	2	*D_W04, D_U04, D_K09*
18.	Technical Safety Engineering	30	3	*D_W03, D_U05, D_U07, D_K05*
19.	Computer-aided operation of machines	20	2	*D_W02, D_U05, D_K05*
20.	Shaping a safe car body	20	2	*D_W01, D_U04, D_K01, D_K05*
21.	Shaping the reliability of machines	30	3	*D_W01, D_U04, D_K01, D_K05*
22.	Composite materials in mechanical engineering	30	3	*D_W01, D_W01, D_U04, D_K01, D_K05*
23.	Mechanics of continuous media 1	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03*
24.	Mechanics of continuous media 2	30	3	*_W01, D_W02, D_W03, D_U05, D_K01, D_K03*
25.	Finite Element Method	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
26.	Methods of analysis of numerical experimental research results	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
27.	Methods of testing the condition of machines	30	3	*D_W03, D_U05, D_K01, D_K03*
28.	Test methods for air filters of internal combustion engines	30	3	*D_W04, D_U WAT02, D_U07, D_U12, D_K02*
29.	Experimental methods for investigating the thermophysical properties of solids	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*
30.	Methods and techniques for testing the mechanical properties of materials	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*
31.	Identification and optimization methods	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*
32.	Numerical Methods in Engineering Applications	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
33.	Numerical Methods in Mechanical Engineering	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
34.	Methods for determining object coordinates	30	3	*D_W04, D_U WAT02, D_U07, D_U12, D_K02*
35.	Methods for designing and optimizing aircraft structures	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*
36.	Constitutive Models of Materials in FEM Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
37.	Modelling of heat transfer processes	30	3	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*
38.	Modeling hydraulic drive systems	30	3	*D_U04, D_W04, D_K01*
39.	Modeling and simulation of mechatronics issues	30	3	*D_W04, D_U04, D_K01*
40.	Modeling and simulation of thermomechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
41.	Modeling and simulation computer programs	20	2	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*
42.	Modeling and simulation of nonlinear mechanical problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
43.	Parametric modeling and structural optimization with FEM	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
44.	Modeling Connections of Thin-walled Structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
45.	Flow modeling	30	3	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*
46.	Modeling machine motion	20	2	*D_U04, D_W04, D_K01*
47.	Modeling composite structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
48.	Modeling of coupled problems (electrothermomechanical-)	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
49.	Modeling of the Contact Phenomenon in Structural Mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
50.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	20	2	*D_U04, D_W03, D_K01*
51.	Renewable energy sources	30	3	*D_W06, D_U WAT02, D_K07*
52.	CAE Engineering Software	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
53.	Experiment planning and optimization of mechanical objects	30	3	*D_W04, D_U04, D_K05*
54.	Basics of road safety	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
55.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*
56.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*
57.	Fundamentals of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
58.	Basics of modeling and simulation of nonlinear mechanical problems	20	2	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
59.	Theoretical foundations of FEM	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
60.	Starting processes of internal combustion engines	30	3	*D_W04, D_U04, D_K01*
61.	Transformations of the quantum structure of matter as a source of energy	30	3	*D_W01, D_W02, D_W06, D_U05, D_K01, D_K03, D_K05*
62.	Predicting the off-road mobility of land platforms	30	3	*D_U04, D_W03, D_K01*
63.	Rheology of lubricating oils	30	3	*D_W01, D_W02, D_U05, D_K01, D_K03, D_K04*
64.	Mechatronic sensors	30	3	*D_W03, D_W04, D_U06, D_K01, D_K04*
65.	Simulation and visualization of system dynamics	30	3	*D_W03, D_W04, D_U01, D_K01, D_K03*
66.	Control systems in mechanical engineering	30	3	*D_U04, D_W03, D_K01*
67.	Development trends in automotive technology	20	2	*D_W01, D_W03, D_U04 D_K01, D_K05*
68.	Theory and organization of machine operation	30	3	*D_W04, D_U06, D_K03*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
69.	Theory of technical systems	30	3	*D_W01, D_W03, D_U01, D_K01, D_K03*
70.	Thermomechanics of materials and studies of thermo-physical properties	30	3	*D_W03, D_W04, D_U01, D_K03*
71.	Tribology	30	3	*D_W03, D_U04, D_K05*
72.	Durability of aircraft structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
73.	Radioelectronic systems in radar systems	30	3	*D_W03, D_W05, D_U04, D_K04*
74.	Validation of numerical models	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
75.	Introduction to the equations of mathematical physics	30	3	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*
76.	Modern machine and vehicle drive systems	30	3	*D_W03, D_U04, D_K05*
77.	Selected Technological and Material Aspects of Powder Metallurgy	30	3	*D_W04, D_U02, D_K01*
78.	Selected methods and techniques of temperature measurement	30	3	*D_W03, D_W04, D_U04, D_K05*
79.	Selected problems of rocket technology	30	3	*D_W03, D_U04, D_K05*
80.	Selected problems of higher algebra	30	3	*D_W03, D_U04, D_K05*
81.	Selected issues of functional analysis	30	3	*D_W03, D_U04, D_K05*
82.	Selected issues of safety and ergonomics of vehicle crews	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
83.	Selected issues of structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
84.	Selected Issues of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
85.	Selected issues of active defence of military vehicles	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
86.	Selected issues of modern programming – introduction to modern programming languages	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
87.	Strength of adhesive joints	30	3	*D_W03, D_U04, D_K05*
88.	Fatigue Strength and Fracture Mechanics	30	3	*D_W01, D_W03, D_U04, D_K05*
89.	Fatigue strength and fracture mechanics of materials and structures	30	3	*D_W01, D_U04, D_K01*
90.	Advanced methods of manufacturing products from sintered powders	30	3	*D_W04, D_U04, D_K01*
91.	Advanced ballistics, modeling, and simulation	30	3	*D_W01, D_U04, D_K01*
92.	Advanced Mathematics	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
93.	Advanced Materials	30	3	*D_W01, D_W03, D_U01, D_K01*
94.	Advanced Material Modeling	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
95.	Advanced modeling in structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
96.	Advanced measurement systems	30	3	*D_W04, D_U04, D_K01*
97.	Application of experimental mechanics in scientific research 1	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
98.	Application of experimental mechanics in scientific research 2	40	4	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
99.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
100.	Material and structural fatigue	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*

Annex V.6

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: chemical sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Analysis of Chemical Warfare Agents	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*
2.	Chemistry and technology of liquid crystal materials	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*
3.	Chemistry and technology of high-energy materials	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*
4.	Electroanalysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
5.	Physics and chemistry of carbon materials	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*
6.	Physicochemical aspects of the explosion	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*
7.	History of chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
8.	Ionization methods in analytics	20	2	*D_W03, D_W04, D_UWAT02, D_K01*
9.	Methods for preparing samples for analysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
10.	Spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
11.	Latest trends in electrochemistry	20	2	*D_W01, D_W03, D_UWAT02, D_U03, D_K01*
12.	Modern nanoporous materials	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*
13.	Modern methods of synthesis of functional organic com-pounds	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*
14.	Signal Processing in Analytical Chemistry	20	2	*D_W03, D_W04, D_U05, D_K03*
15.	Synthesis of liquid crystals	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*
16.	Introduction to Spectroscopy	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
17.	Modern analytical chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
18.	Advanced pyrotechnics	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
19.	Application of gas chromatography in physicochemical studies	20	2	*D_W WAT01, D_W01, D_W02, D_U WAT01, D_U WAT02, D_K01, D_K03*

Annex V.7

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: security sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Social research in security sciences	20	2	*D_W WAT01; D_W01; D_W06; D_U03; D_K03*
2.	Information security	20	2	*D_W06; D_U01; D_K05*
3.	Evaluation of security system processes and designs	20	2	*D_W03; D_U04; D_K05*
4.	Geography, Geographic Information Systems in Crisis Management	20	2	*D_W03; D_U04; D_K05*
5.	Systems Research Methodology	20	2	*D_W02; D_W04; D_U01; D_U05: D_K01; D_K03*
6.	International Military Relations	20	2	*D_W02; D_U04; D_K05*
7.	Problems of the information society	20	2	*D_W02; D_U04; D_K05*
8.	Strategies and concepts of state security management	20	2	*D_W02; D_U04; D_K05*
9.	Security theory	20	2	*D_W02; D_W05; D_U01; D_K05*
10.	Modern information warfare	20	2	*D_W02; D_W05; D_U01; D_U04; D_K05*
11.	Geopolitics and geostrategy in the modern world.	20	2	*D_W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D_K03; D_K04; D_K05;*
12.	Economic security in the face of information and post-industrial changes.	20	2	*D_W03; D_U WAT02; D_U05; D_K03; D_K04; D_K05;*
13.	Military security in the 21st century: opportunities, challenges, threats.	20	2	*D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D_K03; D_K04; D_K05;*
14.	Environmental security on a global, regional and national scale.	20	2	*D_W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D_K03; D_K04; D_K05;*
15.	Energy security of countries in the face of socio-economic transformation.	20	2	*D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D_K03; D_K04; D_K05;*
16.	Forecasting of international threats: methods, techniques and tools.	20	2	*D_W03; D_W04; D_U WHAT01;; D_U05; D_U13; D_K03; D_K04; D_K05;*
17.	The Culture of Security in National and International Relations.	20	2	*D_U WAT01; D_U WAT02; D_U05; D_U13; D_K03; D_K04; D_K05;*

Annex VI.1
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	Curriculum content
1.	Administering computer networks	IP networks. Routing in IP networks. Basics of Windows administration. Fundamentals of Linux system administration. Configuration of network devices. Services in LAN networks. Services in TCP/IP networks. Computer network diagnostics. Access networks. Network service servers. Computer network security.
2.	Data analysis experimental aided by computer-aided	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of univariate and multivariate data, processing of multidimensional experimental results using linear transformations, problems of discrimination including linear and non-linearly separable problems using simple methods of producing separating hyperplanes, methods of minimum distance classification, nearest neighborhood, k-means and hierarchical grouping.
3.	Digital Computer vision	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
4.	Detectors Radiation Optical	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, photodiodes p-n, pin, APD, with Schottky barrier, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages.
5.	Electromechanical Energy converters and signals	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements.
6.	English for electronics	Mathematical symbols and operations. Notion of a function. Differential and integral calculus. Geometry Series and sequences. Vector, matrix and sets calculus. Probability and mathematical statistics. Uncertainties of measurements. Basic physical quantities and their units. Notion of a physical field Electric properties of media. Lasers and light properties. Theory of solids. Structure and constituents of an atom. Basics of quantum theory of an atom, wave function. Chemical elements and molecules' formation. Types of chemical bonding. Basic chemical nomenclature of chemical substances. Elements of materials engineering. General physicochemical characteristics of matter. Mechanical, electric, magnetic and optical properties of a substance Classes of materials. Thin films deposition technologies.
7.	Laser Physics	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
8.	Physics Laser Centers	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction. Energy levels of transition group metal ions. Phenomena of energy transfer between ions in active media.
9.	Photovoltaics	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.

Lp.	Item Name	Curriculum content
10.	Functionalized nanomaterials Optoelectronic	Modern optoelectronic materials – introduction. The issue of functionalization in terms of increasing safety. Graphene - the production of properties. Carbon nanotubes – production and properties. Fullerenes – production and properties. Boron nitride production and properties. Methods of functioning of surface structures. Use core-shield systems. The role of nanomaterial geometry. Selection of composites for optoelectronic functioning. Spectroscopic methods for the study of optoelectronic nanostructures. Examples of functional solutions for special applications.
11.	Generation Radiation supercontinuum	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
12.	Engineering image information	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality - key system components, application solutions.
13.	Coding and recognition radio transmissions	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
14.	Crystallography	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
15.	Laser absorption spectroscopy in gas sensors	Discussion of gas detection methods and definition of gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
16.	Laser-plasma X-ray sources and extreme ultraviolet (EUV)	The aim of the course is to learn about the methods of producing X-rays and extreme ultraviolet radiation (EUV), to learn the basics of laser-generated plasma physics and X-ray and EUV optics, to learn the principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), to learn examples of the use of these sources in science and modern technology.
17.	Lasers for medical applications	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications

Lp.	Item Name	Curriculum content
		and the therapeutic and diagnostic effects obtained.
18.	Pico- and femtosecond	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
19.	Fiber lasers	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals - selected issues.
20.	Mathematical Field Models Electromagnetic	Mathematical differential relationships. Distribution. Orthogonal functions in electromagnetic applications. Wave propagation in materials and metamaterials. Analytical models for calculating the radiation field. Potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the far zone criterion for real antennas. Differential equations in electromagnetic problems. Computational electromagnetism - differential methods.
21.	Method finite elements	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
22.	Methods of analysis and measurement of random signals	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
23.	Methods and tools data mining	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
24.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations - condition index. Gaussian method of numerical solving of a system of linear equations. Direct methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Numerical methods solving ordinary differential equations.
25.	Methods of logical synthesis	The following educational contents will be presented as part of the course: Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
26.	Surveying and measurements Optoelectronic	General conditions for carrying out measurements. Optoelectronic measurement sensors basic technical and metrological parameters. Measurement of the power and energy of optical radiation. Testing of optical radiation power and energy

Lp.	Item Name	Curriculum content
		meters. Laser distance and speed measurements. Measurement of wavelength and spectrum of optical radiation. Measurement of wavelength and spectrum of optical radiation. Measurements of polarization and coherence (degree of coherence) of laser radiation. Testing the resolving power of the monochromator, testing the spectrum of the selected laser. Lidars in research and their applications. Interferometric measurements. Optoelectronic measurement and recording systems.
27.	Modeling of physical phenomena and processes	Approximation (Linear Regression, Polynomial Mean Quadratic Approximation, Trigonometric Approximation, Fast Fourier Transform) Numerical Integration and Differentiation (Rectangular, Trapezoid, Simpson, Gaussian Quadrature). Ordinary differential equations (Euler's method, solution stability, Runge-Kutta method, systems of equations), laser modeling. Partial differential equations - Parabolic equations (Thermal conductivity – a simplified model of the interaction of laser radiation with matter), wave equation Numerical modeling of laser radiation diffraction in the paraxial approximation - a method of development into a number of eigenfunctions
28.	Nonlinear Radiation Conversion Laser	Elements of crystallography and crystal optics. Properties of uniaxial and diaxial crystals (KDP, LiJO3, LiNbO3, KTP, BBO, LBO etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector synchronizm. Generation 2□ and summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits.
29.	Scientific and engineering calculations	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
30.	Optoelectronics in systems Security	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.
31.	Laser optics	ABCD-2D and 4D methods in geometric and wave optics. Laser beam parameters and methods of their measurement. Gauss-Schell model of laser beam transformation in optical systems. Basics of coupling and shaping laser beams. Properties of the resonator and Fabry-Perot interferometer. Elements of the theory of resonators, mode structure of laser radiation. Thermo-optics components.
32.	Coherent Light Optics	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.
33.	Plasma in science and technology	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
34.	Remote Sensing Basics	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron paramagnetic resonance (EPR) (microwave spectroscopy). Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems. Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.
35.	Designing safety systems	Security strategy and principles for creating technical protections. Discussion of normative principles. Defining a set of good industry practices. Determination of

Lp.	Item Name	Curriculum content
		the scope of possible technical protection measures. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor applications. Characteristics of a set of protective devices for outdoor applications. Determination of working conditions and restrictions in this respect. Structure of the technical and detailed design. Discussion of individual scopes of the detailed technical design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Discussion of the principles of detailed design and cost estimation. Design study in the field of technical and detailed design. Discussion of the required resources to determine the basis for the implementation of the project. Threat analysis. The concept of technical protection of the security system. Discussion of the principles of conducting threat analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. A detailed discussion of possible attack scenarios and verification of the possibility of technical security against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Indication of specific ways of description and graphic representation of the technical design. Presentation of the method of organizing documentation. Discussion of exemplary technical designs of executive structures of critical infrastructure facilities. Documents related to the technical detailed design. A list of documents related to the technical design. Presentation of the principles of developing an investor's and "blind" cost estimate. Indication of the need to compile technical catalogues and technical data sheets of devices.
36.	ICs Programmable and specialized	The aim of the course is to familiarize students with the technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). The lectures will discuss the principles of designing the topography of digital circuits, methods of distributing power and distribution of clock signals, I/O buffers, IP blocks and design tools. The discussed issues will be verified practically as part of laboratory exercises, during which students will develop digital circuits in the selected ASIC or FPGA technology. The main effect of education will be the acquisition of practical skills in designing integrated digital circuits.
37.	Selected problems of digital signal processing	Discrete Fourier Transformation (DFT). Practical aspects of Fourier transformation. Wavelet transformation, mathematical basis. Mallat algorithm of decomposition and reconstruction of signals, 2-D wavelet transformation. Filtering of discrete signals, discrete filters, design of discrete filters, application of Matlab in filter design and analysis. Statistical signal processing. Statistical moments, correlation functions and their properties. Power spectral density. Estimation of spectra and moments. Higher order statistics.
38.	Acoustic sensors	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
39.	Microwave sensors in radar	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
40.	Smart radio networks	Smart radio network concept. CR architectures. Semantic context of CR. Problems of teaching in the CR system. Dynamic spectrum management. Problems of reception in CR. Ad-hoc CR networks, collaborative MIMO. Standards for CR networks. Security problems in CR. Current research programs in the area of CR.
41.	Optical spectroscopy in applications Biomedical	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński diagram Spectroscopic arrangement – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
42.	Digital Systems in the devices optoelectronic	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
43.	Test and measurement	Signal conditioning systems. Control and measurement systems. Measurement

Lp.	Item Name	Curriculum content
	systems in the test laboratory	signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
44.	Fiber optic technology	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.
45.	Terahertz technique	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
46.	Concealment technique information (steganography)	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of hiding data – cases and scenarios of action.
47.	Thin film technologies	Historical outline of the importance of thin layers. The issue of the top layer. Thin film theory. Theory of thin film growth. Anti-reflective coatings and laser mirrors. Dichroic mirrors. Thin film polarizers. Radiation dividers. Interference and absorption filters. Solar cells. Methods of designing and manufacturing thin films. The role of nanocomposite geometry in increasing the optoelectronic functionality of surface structures. Methods of testing the properties of thin films. Quality control of surfaces and thin-film coatings – standards. Examples of functional solutions for special applications.
48.	Thermal imaging and infrared technology	Application of thermal radiation polarization in thermal imaging. Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Thermal imaging systems supporting the landing of aircraft. Modern infrared sensors with shaped and programmable detection zones. Active thermal imaging, measurement capabilities and prospects for its application. Multiband pyrometry for underwater oil exploration.
49.	Detection systems Radiation Optical	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
50.	Today's size transducers Physical	The concept of a measuring transducer. Classifications of measuring transducers. Static and dynamic properties of transducers. Resistance strain gauges. Condenser drivers. Piezoelectric transducers. Inductive transducers. Magnetoelastic transducers. Thermoelectric transducers. Pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic transducers. Acoustic electronic transducers. Photoacoustic and photonic transducers. Integrated transducers.
51.	Selected issues of the operation of anthropotechnical systems	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
52.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force. Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
53.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials.

Lp.	Item Name	Curriculum content
		Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.
54.	Advanced technology microelectronics	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy structure of semiconductors.
55.	Selected issues of the operation of anthropotechnical systems	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
56.	Laser applications in technology	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: technical informatics and telecommunications

Lp.	Item Name	Curriculum content
1.	Quantum Algorithms III	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	Algorithm Analysis III	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	Analysis and synthesis of visual information III	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	ICT Systems Diagnostics III	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
5.	Efficiency of ICT systems III	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
6.	Elements of forecast theory III	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.
7.	Software Evaluation III	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation. Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability

Lp.	Item Name	Curriculum content
		models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
8.	Physical Foundations of Quantum Information III	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
9.	Computer Graphics III	Introduction to computer graphics, basic applications and issues. Digital image - sampling, quantization, image perception, color description, external devices. 2D graphics - raster primitives, transformations, matrix transformations. 2D graphics - special effects, morphing/warping, filtration, texture filtration. Introduction to 3D graphics - representation, transformations, basic shading algorithms, raytracing, radiosity.
10.	Software Quality Engineering III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
11.	Cryptology III	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
12.	Mathematical Methods of Decision Support III	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-making under uncertainty. Methods of determining the representation of sets of irreparable decisions. Methods for determining "approximate sets of optimal solutions". Examples of modeling decision support processes.
13.	Discrete Mathematics III	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers. Break down the number into its components. Asymptotics. Creating functions. Asymptotic nota-

Lp.	Item Name	Curriculum content
		tions. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
14.	Generative methods and aspect in the manufacture of software III	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
15.	Numerical methods III	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
16.	Multi-Criteria Optimization Methods III	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
17.	Modeling Mathematics III	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin, maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of indistinguishability. Lower and upper approximation of the set. Approximation accuracy. Optimal decisions with approximate data knowledge. Decision boards. Deterministic and non-deterministic rules. Uncertain variables.
18.	Modelling and network verification ICT III	Basics of verification of ICT systems (ST) based on formal models: model verification, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-

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		2, CPN Tools, UPPAAL.
19.	Modeling human-computer interaction III	Computer systems with a user – operator. User activity in the system and evaluation of the quality of operation. Modeling the user experience. GOMS modeling method. Keystroke-Level Model method. THERP method and other methods. A Markov model to assess the quality of user input. Semimarkian model for assessing the quality of user input. Analytical and simulation tools for quality modeling. Examples. Modeling the quality of user experience in systems with strong constraints. Problems with assessing the quality of user experience.
20.	Modeling Conflict Situations III	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
21.	Process modeling, simulation and analysis Business Enterprises III	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
22.	Software Reliability III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and programmatic methods of shaping reliability software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability indicators, finite error models, infinite error models. Models in the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1-1988, IEEE/ANSI Std 982.2-1988.
23.	Reliability of Systems III	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for renewable facilities with zero renewal. Reliability of renewable facilities with non-zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability

Lp.	Item Name	Curriculum content
		indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of structures reliability. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
24.	Optimization III	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
25.	Probabilistic III	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.
26.	Stochastic Processes III	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
27.	Recognition and image processing III	Introduction to the issues of digital recognition and image processing. Basic problems related to digital image acquisition and how to solve them. Frequency methods in digital image processing. Basics of using transforms in digital image processing and analysis. Spatial methods in digital image processing. Improving the quality of images with the use of convolutional, ranking, logical filters - their advantages, disadvantages, ways of implementation. Introduction to digital image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Basic methods of image identification: classification in the space of features, structural method.
28.	Neural networks and fuzzy logic III	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
29.	Stochastic Exploitation Models III	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
30.	Computer Simulation III	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simula-

Lp.	Item Name	Curriculum content
		tion systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
31.	Database Systems III	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
32.	Systems ICT III	Route and link availability control in the LAN environment: LAN link availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol : the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Frame Relay protocol: Frame Relay protocol design features, - configuring the Frame Relay protocol, diagnosing and resolving problems resulting from protocol misconfiguration. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IPSec protocol, MPLS-based VPNs.
33.	Decision support systems III	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
34.	Artificial Intelligence III	Paradigms of artificial intelligence and areas of its applications, limitations of artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search, simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
35.	Theoretical foundations of computer science III	Algorithmic theory of information. Accuracy and correctness of algorithms. Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transfor-

Lp.	Item Name	Curriculum content
		mations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
36.	Graph and Network Theory III	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. Complex graph as a special type of graphs. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms. Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
37.	Project management and Processes III	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of projects and processes, planning the usability and functionality of project processes, planning the reliability of project activities, planning of control and verification of results, project risk management. Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of

Lp.	Item Name	Curriculum content
		innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the enterprise, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, management of communication in the project, methods and techniques of process improvement, models of process management development. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of the rhomboid model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
38.	Complex Data Structure III	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering and transport

Lp.	Item Name	Curriculum content
1.	Safety and reliability of building structures	Knowledge in the field of safety and reliability of building structures. Classifications and rules for shaping the load-bearing structures of buildings and the conditions for assessing their safety. Methods of description and distribution of random variables. Functions of reliability and damage intensity. Methodology for conducting reliability tests, risk assessment, the safety of building maintenance and their effectiveness.
2.	Dynamic interaction of building structures with a soil medium	The course discusses methods of formulating computational models of the dynamics of structural elements and systems as well as the ground foundation of the building. Determination of the physical characteristics of the soil medium under static and dynamic loads. Influence of the content of the phases on the parameters of the substrate.
3.	Environmental physics	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits. Types of light sources for lighting. Indoor and outdoor illumination, luminous flux, illuminance, luminous efficacy, light source spectrum, standard observer, objective determination of the source color.

Lp.	Item Name	Curriculum content
4.	Modeling of thermal and humidity processes	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
5.	Identification of loads and structural systems	The module deals with the identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of the initiating reactions of the supporting systems of objects, which are revealed by static or dynamic displacements or vibration frequencies.
6.	Investment process in the construction industry	Organization of construction investments, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
7.	Mechanics of road and airport runway soil foundations	Modeling of the soil as a single-phase or three-phase continuum depending on the type of soil (cohesive or no-cohesive). Stiffness and load carrying capacity of the ground as the problem of an elastic half-space. Dynamic effects generated by moving loads.
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
9.	Design methods of bridge structures Folding	Presentation of the structure of folding bridges with determination of their technical and operational parameters. Next, the theory of calculating folding bridges taking into account assembly clearances for objects in a static and dynamic system is presented. The module completes the development of a bridge crossing design from a folding bridge structure
10.	Design methods of the experiment	The essence of experimental research. Resistance extensometry. Measurements and analysis of measurement errors. Organization of the measurement line. Experimental methods of testing materials in simple stress conditions - tensile, compression, shear, bend, torsion tests. Materials testing in complex stress states. Assessment of rheological properties of materials - creep and relaxation. Optical research methods in mechanics – elastooptics, optical, mesh and holographic interferometry.
11.	Modeling the behavior of elements and structures reinforced concrete	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
12.	Nonlinearities geometric and physical in structural mechanics	Deformations of flaccid structures and bodies with low rigidity require the use of geometric relationships with linear and nonlinear terms. The consequences of such deformations are reflected in the equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.

Lp.	Item Name	Curriculum content
13.	Impact explosives on defensive structures	The module considers the physics of phenomena generated by explosive charges and fuel-air mixtures. Then, the methods of determining the parameters of explosive loads are presented. The types of mechanisms destroying the load-bearing elements and structures of the building generated by the considered loads are analyzed.
14.	Scheduling and costing systems for construction works	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
15.	Engineering of building materials	Contemporary trends in the modification of building, construction and finishing materials. Technologies of preparation, implementation and optimal procedures for incorporating materials and products under building conditions. Structure and material considerations of composites used in construction. The role of additives and admixtures in buildings technologies.
16.	Cartographic methods of research	The course will cover issues related to the use of maps for the description, analysis and scientific cognition of phenomena, including, above all, cartometric research, mathematical and statistical analysis and methods of mathematical theory of information. Issues related to distribution analyses (potential maps, concentration analyses), dynamics of phenomena, as well as correlation methods and trend methods will be implemented.
17.	Data mining Spatial	The course includes an overview of methods of exploratory data analysis with particular emphasis on geospatial data, including the issues of classification and grouping, reduction of the number of variables, and finding spatial patterns. Classification using decision trees and the Byesowski classifier, hierarchical grouping, and quality assessment of classifiers and model verification will also be discussed.
18.	Data science in geospatial research	The course covers the issues of advanced processing, analysis and modeling of geospatial data. In particular, searching for trends and dependencies using exploratory data analysis, machine learning and artificial intelligence techniques. The discussed examples concern: real estate market, changes in land cover, distribution of population. The issues of data quality and their impact on the effect of forecasting and modeling, as well as effective reporting and visualization of results will be considered.
19.	Advanced methods of implementation of studies photogrammetric	Problems of filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF. Fundamental problems of contemporary digital photogrammetry. Digital image acquisition systems – photogrammetric digital cameras and VHRS and Nano satellite systems. Remote sensing and photogrammetric methods of data acquisition. Modern photogrammetric technologies – their applications in the development of site and elevation maps, digital terrain model and orthophotomaps, as well as 3D spatial maps. Application of Computational Intelligence Algorithms in contemporary photogrammetric studies. Characteristics of new multi-image fitting methods. Methodology for developing dense point clouds from images.
20.	Programming in spatial information systems	The course includes the presentation of basic issues related to programming - discussion of the programming environment used, the concept of procedure, functions and data processing instructions used. The method of accessing and processing spatial data directly using programming code will be discussed. Libraries for processing spatial data in the .NET environment will be discussed, and the possibilities of automating the ArcGIS environment using Python will be presented. As a project task, the student will perform a sample project automating the process of spatial data processing, related to the subject of his doctoral dissertation.
21.	Reference systems in geosciences	We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference. To be understood in context, when the motion of the Earth's crust is observed, it must be referenced. The global geodetic frame of reference is the fundamental basis for measuring worldwide processes and is crucial for its proper interpretation especially for climatic studies. A terrestrial reference frame provides a set of coordinates of some points located on the Earth's surface. It can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space. This rotation is assessed with respect to a frame tied to stellar objects, called a celestial reference frame. The Earth Orientation Parameters (EOPs) connect these two frames together. Nowadays, four main

Lp.	Item Name	Curriculum content
		geodetic techniques are used to compute accurate coordinates: the GPS (Global Positioning System), VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite). They all use networks of stations located on sites covering the whole Earth. Modern realizations are of kinematic type, which means that they include station positions and velocities. They model secular Earth's crust changes that is why they can be used to compare observations from different epochs. The Ph.D. students will learn about advancements of the International Terrestrial Reference System (ITRS) which is a World spatial reference system co-rotating with the Earth in its diurnal motion in space for the geodetic, but also astronomical, and geophysical communities.
22.	Global Geodetic Observing System	Global Geodetic Observing System (GGOS) is the Observing System of the International Association of Geodesy (IAG). GGOS and its related research and services address the relevant science issues related to geodesy, geodynamics and geophysics in the 21st century, but also issues relevant to society, like global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea level estimations and ocean forecasting, or the space weather. The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS mission is to: (i) provide the observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, (ii) provide the global geodetic frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications, and (iii) benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built. Within this subject Ph.D. students will advance their understanding of the dynamic Earth system by quantifying our planet's changes in space and time and learn about the integration within the geodetic, geodynamic and geophysical communities at the highest level, in service to the technical community and society as a whole.
23.	Modern photogrammetric techniques	A modern approach to photogrammetric studies based on the use of the latest techniques of processing imagery obtained from various altitudes and the use of their geometric relationships in the field of situational and elevation measurement in areas including: development and updating of maps, feeding topographic databases, supporting the construction of 3D cadastre, as well as cooperation with mobile systems in the field of building virtual reality at various levels of detail.
24.	Selected methods numerical in geodesy	The course concerns the practical use of numerical methods to solve scientific and technical problems (geodesy), presents the ideas and concepts of numerical methods, illustrates numerical algorithms, contains elements of programming – computational scripts. The PhD student learns the use of selected tool libraries of scripting languages such as Matlab, Octave and Scilab.
25.	Methods of parallel data processing	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods and functions of the Parallel Computing and MATLAB Distributed Computing Server Toolbox modules.
26.	Mathematical foundations of digital image processing	Creating gradient and edge filter masks based on differential diagrams constructed using the finite difference method (FDM) and the finite element method (FEM) (convergence, agreement, order of precision, π- as the first form of differential approximation). Spectral properties of masks (matrices of the third and fifth order), including the spectral transfer function and its graphical presentation. The goodness of the mask is defined as the quotient of the spectral transfer function of the filter under study and the visual transfer function of the differential transfer of the Laplace operator. Operations on masks (addition, subtraction, 45° rotation), determining the form of the differential operator related to the results of these transformations (Laplacian, bi-Laplacian, etc.). Filters that identify only corners (vertices). Bi-Laplacian mask vs. Harris corner detector.
27.	Numerical methods with linear algebra	Vector norm, matrix norm, induced norm. Norm 1, 2 and maximum. Matrix conditioning indicator. The use of linear algebra methods in numerical (differential) solving of mathematical physics problems (advection equation, diffusion, diffusion problem with advection). Convergence and stability of the differential method. Spectral transfer operator. π- a form of the first differential approximation. Numerical diffusion, creation. Analysis of selected differential schemes in terms of spec-

Lp.	Item Name	Curriculum content
		tral properties – explicit, implicit, semi-implicit scheme, Crakn-Nicholson, Crank-Nicholson-Galerkin. Dissipation and dispersion in Lax-Wendroff and Beam-Warming schemes used in civil engineering and trance-sport.
28.	Time series analysis in geodesy	This lecture is dedicated to doctoral students dealing with geodetic issues. In the case of geodetic observations, we mainly deal with the finite number of data as well as the occurring measurement errors. At the beginning, basic definitions regarding time series analyzes will be presented such as such as: stochastic process, signal, white and red noise, convolution, the Fourier and Hilbert transforms. Next the possibilities of analyzing time series and the relationships between them will be presented by introduction of the autocovariance and cross-covariance functions and their estimations as well as power spectrum, cross-spectrum, time lag and coherence. After introduction to digital filters including examples of Gauss, Ormsby, Butterworth and Fourier transform filter the following spectral analyzes methods will be presented: Blackman-Tuckey method, Maximum Entropy Spectral Analysis, Fourier Transform Band Pass Filter (FTPBF) Spectral Analysis. Next part of the lecture will be dedicated to prediction methods such as autoregressive and autocovariance forecasts. In the case of non-stationary time series in which the amplitudes and phases of oscillations change over time, time-frequency analyzes such as: Gabor transform, wavelet transform and Fourier transform band pass filter spectra-temporal analysis will be presented. In order to determine time-varying amplitudes and phases in time series the combination of the FTPBF with the Hilbert transform will be presented. To detect common signals in two time series the wavelet based semblance filtering method will be presented.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	Curriculum content
1.	Structural studies by diffraction methods X-ray	Familiarization with the basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	Structural studies by scanning microscopy	Teach the basic concepts used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Familiarize yourself with the preparation used in reflection and transmission electron microscopy. Selected methods of advanced microscopic research (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of images and breakthroughs).
3.	Mechanical Properties Testing of Engineering Plastics	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	The aim of this subject module is to familiarize PhD students with the physical basis of electro-optical effects in Liquid Crystals (CK). PhD students will learn: selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals. This module will enable you to observe and understand the operation of liquid crystal displays, light wave phase modulators, eye protection filters and equipment against harmful electromagnetic radiation, which are ubiquitous in our lives.
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	The course introduces the student to issues related to the study of materials (in particular materials for storing hydrogen in the solid phase) with the use of: differential calorimetry, thermogravimetry and analysis by volumetric methods. The following will be discussed: types of equipment used for these tests, the principle of its operation, calibration methods, good practices of use, advantages, advantages, capabilities and limitations. Students will be introduced to the basics of test result analysis, result correction and selection of test parameters to obtain the best results. Practical classes will be conducted using the above-mentioned research techniques in application to selected materials.
6.	Semiconductor materials for optoelectronic applications	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic semiconductors).
7.	Nano and ultra-crystalline construction materials	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	Nanoporous anodic aluminum oxide : synthesis, design and applications	Lectures in the subject: "Nanoporous anodic aluminum oxide: synthesis, design and applications" will cover the following topics: - Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.); - Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electro-

Lp.	Item Name	Curriculum content
		chemical synthesis (temperature, voltage, time); - The process of self-organization of matrix pores into a hexagonal system; - Soft anodization; - Hard anodizing; - Pulsed anodization; - Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods); - Applications of anodic aluminum oxide matrix (biosensors, filters, opto-electronic components, tissue engineering, etc.); - New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	Non-telecommunications applications of fiber optics	A subject discussing the technique of interference (phase) fiber optic sensors. The course defines the correct terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the determination of the role of the transducer as well as the optical and electronic processing of the signal. Introduction to two methods of building point sensors and about the distributed detection field as well as issues related to the multiplication of point sensors. The course includes within the framework of demonstration laboratories with the basic elements of the fiber optic sensor system.
10.	Final acceptance of machine and plant parts using coordinate measuring techniques, tactile profilometry and reverse engineering methods	The use of coordinate measuring techniques, tactile profilometry and reverse engineering methods at various stages of the technological process. Metrological properties of coordinate measuring machines, tactile profilometers and reverse engineering devices. Preparation and use of a multi-sensor measuring machine, tactile profilometer and 3D scanner to carry out measurements as part of the final acceptance of machine and equipment parts. Analysis of the results obtained, estimation of measurement uncertainty, final conclusions
11.	Experiment planning and data analysis using Origin and Statistica	Most of the research techniques used today allow for a large amount of experimental data. However, the problem is their processing and further analysis. The use of appropriate computer programs can significantly facilitate and shorten this task. The same is true for planning an experiment. Knowledge of appropriate statistical methods can significantly reduce the number of experiments without compromising the quality of the results obtained. During the workshop, participants will be introduced to the possibilities offered by Origin and Statistica programs in the field of experiment planning and data analysis.
12.	Basic properties of liquid crystals	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	Keysight Vee and Lab View for Data Control and Processing	Getting to know the basics of programming in LabView, including mastering the logic of the so-called graphic language. Mastering basic programming structures such as sequential blocks, for loops, while structures, feedback, etc. Mastering the use of objects of various types (numeric, string, bool), including in the form of matrices and clusters. Mastering basic methods of data processing and transfer. Development of own program algorithm for controlling a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Familiarization with the basics of programming in Keysight Vee, including mastering the logic of the so-called graphic language. Mastering basic programming structures such as sequential blocks, loops, selection structures, conditional statements, etc. Mastering how to use objects of various types, including matrices and complex variables. Mastering basic methods of data processing and transfer. Getting to know the Keysight Vee – MS Excel cooperation. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	Designing technological processes for incremental Direct Deposition methods	Designing elements of machine parts and devices using solid and surface modeling, taking into account the specificity of 3D printing. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological

Lp.	Item Name	Curriculum content
		process design - production of the target production series. Basics of regeneration of elements of machine parts and devices using the LENS technique.
15.	Dielectric spectroscopy	A course introducing dielectric spectroscopy (impedance spectroscopy/radio range spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics in the analysis of the properties of materials used in electronics. It presents electrical phenomena at the atomic, molecular and macroscopic (medium) levels. It presents the theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. It takes into account parasitic effects in impedance measurements. It familiarizes students with research equipment (impedance analyzers), experiments and analysis of experimental data in the context of the properties of various materials.
16.	Structural Determinants of Material Properties	A form of materials engineering workshops improving the professionalism of the approach to solving scientific problems in the area of materials and technology. Arrangement of seminar working discussions - lecture - (only) on request, on a selected topic. Improvement in terminology, methodology, critical reception of external data, critical evaluation of own results. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions – mainly and on the example of the needs of own doctoral projects. Discussion of legal conditions in the field of organization and financing of research, problems of scientific integrity and ethics of scientists.
17.	Modern methods of material characterization	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.
18.	Contemporary information imaging systems and directions of their development	Modern imaging systems for direct observation: liquid crystal, organic LEDs, microleds, flexible and roll-up displays. Discussion of the effects and materials used. The level of solutions achieved, limitations resulting from the physics of effects, material possibilities, available technology. Projection systems used effects, solutions ranging from cinema systems through didactic systems to micro-projectors. Directions of development of displays and projection systems. Particular emphasis will be placed on combining knowledge about the physical effects used in the construction of displays, new materials (including nano- structures used in LCDs, OLEDs and microLEDs), and the possibilities of modern technology with compliance with environmental protection requirements.
19.	High-energy ball milling and mechanical synthesis	The course introduces the student to issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. The audience will be introduced to different types of ball mills, the principle of their operation, the possibilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.
20.	Advanced materials for hydrogen storage	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity hydrogen storage materials. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
21.	Basics of plasmonics and metamaterials	The course introduces basic definitions of plasmonics and metamaterials. The physical basics, the interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces are discussed. It presents the technological conditions for the implementation of one-, two- and three-dimensional metamaterial structures. The physical and technological requirements and limitations for different types of metamaterials are discussed, as well as the use of classical technologies for the production of nano- and metamaterials. The PhD student will learn about methods of simulation of the properties of selected metamaterial and plasmonic structures and methods of characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. The applications of metamaterial structures in photonic devices and the prospects for the development of nano- and metamaterials with particular emphasis on

Lp.	Item Name	Curriculum content
		military applications will be discussed.
22.	Optoelectronic Imaging and Information Processing Techniques	The PhD student will learn about the issues of color vision, the perception of black-and-white and color information, and the human-display-imaging interdependence, display requirements, and ergonomics of various types of imagery. The physical and theoretical basis of the effects used in displays and their determinants will be presented. Active displays - fluorescent, plasma, electroluminescent, construction, characteristic parameters, purpose and passive displays - liquid crystal, electrophoretic, structure, parameters and conditions of applications will be discussed. A lot of space will be devoted to segmented and multiplex liquid crystal displays as well as active matrix controlled liquid crystal displays. Projection systems, large-format displays, purpose, advantages and disadvantages will be discussed. The PhD student will learn about organic and inorganic materials for displays and the characteristics of their properties and elements of display production technology and the characteristics of technological processes, methods of control and evaluation of display performance parameters. Methods of three-dimensional imagery, methods of implementation and application, teleimmersion will be presented.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

Lp.	Item Name	Curriculum content
1.	FEM Analysis in Load-Bearing Structures	The course will discuss the theoretical foundations of numerical methods of analysis of load-bearing structures in the linear range (including multi-stage analyses), the strategy of computer simulation of FEM of two- and three-dimensional problems in the field of mechanics and strength of materials, and the methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphic preprocessors (mainly MSC. Patran). PhD students will independently build 2D and 3D models for analysis in the field of selected engineering issues, perform calculations with attention to the selection of optimal analysis parameters and assess the correctness of calculation results using analytical methods and available experimental test results, on the example of elements and subassemblies of load-bearing structures.
2.	Numerical analyses of fracture mechanics	The aim of the course is to provide a doctoral student with knowledge in the field of the theory of fracture mechanics and algorithms for solving problems of fracture mechanics through numerical calculations. The theoretical part covers the following issues: basics of fracture mechanics, stress intensity factor, strength criteria in fracture mechanics, numerical methods for determining the stress intensity factor, methodology of calculations. The laboratory aims to familiarize doctoral students with the possibility of using FEM software to analyze fracture mechanics problems.
3.	Autonomy of mobile robots	Basic terms and definitions of mobile robots. Basics of wheeled robot control. Navigation with markers in the robot's environment. Issues of navigation, self-localization, odometry in connection with the construction of the robot. Determining the position of the robot based on the map. Vision systems in mobile robotics.
4.	Experimental tests of motor vehicles	Identification of the research target, selection of the test method for the intended use of the results. Validation of research methods and procedures. Principles for demonstrating equivalence of methods. Vehicle approval test procedure. Selected methods of type-approval tests of vehicles and their components. Rules for the selection of measuring equipment. Principles of maintaining traceability during tests, calibration and testing of measuring equipment. Criteria for checking. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty. Analysis and presentation of research results. Assessment of the validity of the test, assessment of the usefulness of the results in the area regulated by law. Practical implementation of selected methods of testing vehicles and their components.
5.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of the human body model and experimental research.
6.	Biofuels	Definitions, types and generations of biofuels. Methods of producing biofuels of different generations. Functional properties of biofuels. Methods of testing biofuels. Development tendencies of biofuels in utility, economic and legal aspects.
7.	Construction and operation of industrial robots	The classes allow you to learn about the construction and principles of operation of industrial robots. Principles of robotization of production lines and environments and languages for programming industrial robots
8.	Digital signal processing	The course prepares students to formulate mathematical models of deterministic signals in digital systems. The lectures present the general principles of time-frequency analysis of digital signals, as well as algorithms and methods of their processing. A lot of emphasis is placed on the hardware implementation of selected algorithms in DSP signal processors.
9.	Design of experiment	The course covers the following issues: •Determined and randomized trial plans •Measure the position and dispersion of the measurement results •Assessment of the significance of the influence of input quantities on the output quantity •Define a function that approximates the object's function •Evaluate the adequacy of the feature and the significance of its coefficients

Lp.	Item Name	Curriculum content
		•Experimental optimization
10.	Dynamics of mechatronic system design	The course allows you to learn about the issues of modeling mechatronic systems, including elements of motion and vibration analysis of linear systems with one and many degrees of freedom, elements of motion analysis of nonlinear mechatronic systems, stability testing of linear and nonlinear mechatronic systems, and provides basic information supported by examples on self-excited vibrations as well as basic methods of measuring vibrations of mechatronic systems
11.	Dynamics of car movement	Modeling the movement of the car. Analysis of the dynamics of rectilinear and curvilinear motion. Modeling the process of a car crashing into an obstacle. Analysis of car vibrations.
12.	Dynamics of hydrostatic systems	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis and its description.
13.	Dynamics of multi-member systems	The course will discuss the theoretical foundations of numerical methods, analysis with the use of rigid solids and the strategy of computer simulation of multibodies with the use of various algorithms for formulating equations of motion and their integration. Various multibody analysis software environments and examples in the field of mechanical engineering will be discussed. Methods of modeling mechanical structures using rigid solids in plane and spatial systems will be presented. PhD students will independently build planar and spatial models using various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected mechanical engineering issues. During the course, they will perform multi-variant numerical analyses with attention to the selection of optimal calculation parameters and assess the correctness of the results obtained using analytical and experimental methods.
14.	Solid collision dynamics	Equations of the dynamics of solid collision. Collision energy balance. Deformation and restitution. Modeling of post-collision motion of solids that are subject to deformation in the area of their contact. Biomechanical models for the analysis of shock loads.
15.	Environmentally friendly operating fluids	Harmful impact of operating fluids on the environment. The essence of biodegradation, ecotoxicity and bioaccumulation and methods of their testing in application to operating fluids. Ecolabeling as a tool in promoting the development of ecological operating fluids. Modern fuels, oils, greases and special liquids with low environmental harm. Production and use of ecological operating fluids in legal, technical, economic and functional aspects. Global trends in the production and use of ecological operating fluids.
16.	Elements of advanced mechanics and discrete modeling in the construction and operation of machines	The item consists of two parts. Part A includes elements of advanced mechanics, paying attention to the basics of variational methods. Part B deals with discrete methods in mechanics, with particular emphasis on the finite element method (FEM). For the purposes of practical operation, the basics of the MATLAB language with its Symbolic Math Toolbox library are discussed, and on the example of a flat truss, all the characteristics of a member (or beam) element necessary to solve problems in the area of statics, dynamics and initial stability are derived.
17.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
18.	Technical Safety Engineering	The subject matter of the course includes: basic concepts in the field of safety engineering (technical hazard, safety hazard, risk of negative impact, risk of damage; functional layout, safety system and rescue equipment of a technical facility); the basics of conducting analyses related to the safety of a technical facility and a qualitative and quantitative approach to technical safety (learning about selected methods and techniques of safety analysis). Functional safety. Issues related to the development and implementation of safety-related machine control systems. Mathematical modeling of security systems.
19.	Computer support for the operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
20.	Shaping safe car body	Body construction – shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
21.	Shaping the reliability of	Selected elements of probabilism in machine reliability. Reliability models of facili-

Lp.	Item Name	Curriculum content
	machines	ties. Durability and wear of machine parts. Testing, evaluating and forecasting machine reliability. Methods to improve reliability. Reliability in normative documents.
22.	Composite materials in the construction and operation of machines	The subject matter of the course allows you to learn about the definition and classification of composite materials. It discusses the properties of composites and their components. It presents selected technologies for the production of composite materials. It introduces the types of research used in the experimental analysis of mechanical properties of composites. It presents the problems of metal-composite connections, as well as operational problems related to composites. It indicates the use of composite materials in technology. The practical element is the acquisition of the ability to perform a simple repair of the composite structure
23.	Mechanics of continuous media 1	The course prepares students to understand 0-n valence tensors determining scalar quantities, vector quantities and tensor quantities in the mechanics of continuous media. The basics of the theory of the material continuum are presented, including material fields, event space, dynamical processes, reference systems, coordinate systems, and the application of the material, spatial and frozen reference frame in the MOC. Elements of tensor calculus are given, including the most commonly used in mechanics of material bodies - simple and double tensor operations. The ability to use field theory operators in a space parameterized by a curvilinear system is discussed. The key issues of kinematics and deformation of deformable bodies as well as deformation and strain tensors are discussed. The principles of conservation in mechanics are discussed in detail - the balances of: mass, momentum, angular momentum, energy and stress tensor. The basic postulates and principles of invariance in the construction of constitutive equations are explained.
24.	Mechanics of continuous media 2	The course contains elements of basic and well-established knowledge about the most important groups of continuous media and their division depending on the behavior of the medium as a function of the value of external forces. Elements of thermodynamics, elastic isotropic, anisotropic and orthotropic media with elements of thermoelasticity and an introduction to the nonlinear theory of elasticity are discussed. Further contents of the course include an introduction to the theory of plasticity, elements of Newtonian and non-Newtonian fluid mechanics, the most important elements of knowledge about viscous materials, viscoelastic fluids and viscoelastic solids. The basic rheological properties of solids and strength hypotheses are also discussed. The course develops the ability to determine the relationships between stresses and strains for individual material groups of continuous media, the use of dimensionless and generalized spatial variables in applied mechanics and the formulation of systems of equations and boundary conditions for isotropic and anisotropic media with elements of thermoelastic interactions.
25.	Element Method Finite	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
26.	Methods of analysis of research results numerical – Experimental	On selected deterministic and stochastic examples, the research methodology will be presented that allows the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
27.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
28.	Test methods for engine air filters	Test methods for the characteristics of effectiveness, absorbency and flow resistance of air filters. Selection of test conditions for filter characteristics. Air filter

Lp.	Item Name	Curriculum content
	Combustion	test benches. Test benches with ejective dust extraction and the use of a particle counter. Test dusts and their characteristics. Methodology for determining the characteristics of efficiency, absorption and flow resistance of air filters by gravimetric method. Methodology for determining the aerodynamic characteristics of the filter. Influence of the technical condition of the air filter on flow resistance .
29.	Experimental methods for testing properties thermophysical Solids	The following issues are included in the course: thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
30.	Methods and techniques for property testing Mechanical Materials	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring deformations during strength tests. Methods of testing the mechanical properties of materials under shock loading conditions.
31.	Identification methods and optimization	The course prepares students to identify mathematical models of dynamical systems using identification methods. As part of the lectures, methods of identification are presented. In addition, the course prepares doctoral students to solve single- and multi-criteria optimization tasks on their own. As part of the lectures, optimization methods are presented. As part of the exercises, PhD students formulate mathematical models based on an identification experiment and solve selected optimization tasks.
32.	Numerical methods in applications Engineering	The course allows you to learn the concepts and basic methods of numerical calculations. In the practical scope, they allow for the development (improvement) of the ability to select appropriate methods of numerical analysis and the ability to design and build - program a computational algorithm
33.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
34.	Methods of determining coordinates of objects	General characteristics of echolocation systems. Tasks of echolocation systems: detection, location, parameter estimation, identification. Methods of detecting echolocation signals. Probability of detection and probability of false alarm. Methods of measuring distances and angles used in the location of objects. Range equation in radiolocation and hydrolocation. Object tracking - Klaman filter. Synthetic aperture echolocation systems.
35.	Design methods and optimization of aviation structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission modeling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
36.	Constitutive Models of Materials in FEM Analysis	As part of the course, a mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. will be presented. Experiments to determine the parameters of the models will also be presented. As part of the exercises, numerical analyses will be carried out using the learned models of materials.
37.	Modeling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software
38.	Modelling	Modeling of hydrostatic drive assemblies, subassemblies, elements and systems.

Lp.	Item Name	Curriculum content
	hydraulic drive systems	Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
39.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
40.	Modelling and simulation computer programs	Concepts and principles related to mathematical modeling and computer simulation. Formulate and transform models. Basic numerical procedures and their applications. Simulation software and programming in the Matlab-Simulink system.
41.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
42.	Problem Modeling and Simulation thermomechanics	Description of issues related to the phenomena of heat energy exchange. Heat conduction and heat transfer. Constitutive equations taking into account the influence of temperature. Conjugate thermoelastic and thermoplastic issues. Thermo-orthotropy.
43.	Modelling parametric and design optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
44.	Modeling Connections of Thin-walled Structures	Overview of thin-walled structures. Materials used in thin-walled structures. Types of connections. Principles for designing selected types of connections, e.g. glue, rivet, screw. Introducing concentrated load into the structure. Modeling thin-walled structures including joints. Analysis of the strength of the selected connection of thin-walled structure elements.
45.	Flow modeling	The course prepares students to obtain well-founded knowledge in the field of the role of computer modeling methods of flow processes in basic and applied problems of fluid motion dynamics. Ability to formulate research projects using simulation methods of research on streamlined issues, consolidating competence in the field of transferring knowledge from the basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver are discussed. Problems of modeling flow turbulence are discussed, including averaged Navier-Stokes equations, turbulent stress tensor, possibilities and problems of modeling turbulence. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES) are discussed informatively. This allows to obtain initial skills in mapping complex objects of simulation research, construction and performing basic operations on computational meshes, analysing the reliability and accuracy of numerical modeling results
46.	Motion modeling Machines	General principles of modeling mechanical, hydrostatic, electromechanical systems. Deterministic and random processes. Dynamics of systems with variable mass.
47.	Modeling composite structures	Introduction. The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.
48.	Modelling conjugate issues (electro-thermomechanical)	The course will present the equations of the mathematical-physical model describing coupled phenomena, as well as the initial-boundary conditions taking into account the influence of various factors and phenomena (thermal, electrical, mechanical). Then, simplifications will be presented that allow its solution using numerical methods. The presented model will be used to analyze thermo-electric and electrothermomechanical phenomena.
49.	Modeling of the Contact Phenomenon in Structural Mechanics	General division of contact phenomena. Mathematical foundations of the description and solution of the problem of contact. Algorithms for defining and solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
50.	Modern design systems and CAD\CAM\ manufacturing	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
51.	Renewable	The importance of energy in the development of modern civilization. Modern

Lp.	Item Name	Curriculum content
	energy sources	fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
52.	CAE Engineering Software	The aim of the course is to familiarize doctoral students with the CAE systems available on the market. The lectures will include an overview of this type of systems with an indication of their purpose and the possibility of use in structural analyses. In addition, doctoral students will learn about their philosophy of work. During laboratory exercises, doctoral students will learn how to independently prepare numerical models for calculations in the static and dynamic range. They will learn how to run calculations and how to present and process the obtained results.
53.	Experiment planning and optimization of mechanical objects	Optimize your experiment using experiment plans and statistical models. Factor plans. Optimization plans. Determined plans. Plans to be analyzed, composition – property. Analysis of the relevance and adequacy of statistical models. Methods of determining the extremum of statistical functions. Examples of the use of experiment optimization in mechanical engineering.
54.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Statistics of road accidents and their interpretation.
55.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
56.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.
57.	Fundamentals of Mechanics of Continuous Media	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.
58.	Basics of modeling and simulation of nonlinear mechanical problems	Numerical methods in the aspect of nonlinear analysis of complex problems in the field of statics. Numerical methods to describe the issue of interactions between bodies. FEM in complex problems of dynamic analysis of a system of bodies.
59.	Theoretical foundations of FEM	The classes are aimed at deepening knowledge about the finite element method. The lecture will discuss the principles of operation of the algorithms that make up the finite element method. Knowledge of these algorithms is essential to properly use FEM for custom tasks and to know and understand the method's limitations and sources of error. Laboratory classes will consist in implementing the knowledge gained during the lecture in FEM calculations. Thanks to the ability to create your own procedures, the user can influence the course of FEM calculations at various stages.
60.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.
61.	Transformations of the quantum structure of matter as a source of energy	Transformation of the quantum structure of matter as a common source of energy released in the processes of fusion and fission of atomic nuclei, during combustion, explosion and detonation. Modern explosives and rocket fuels, interpretation and modeling of transformation processes. Issues of operation of machinery and equipment containing or in contact with hazardous materials.
62.	Predicting the off-road mobility of land platforms	NG NRMM (New Generation NATO Reference Mobility Model) tools that allow to predict the vehicle's ability to move in specific/difficult terrain conditions. The course will include techniques and technologies, methodologies and tools for determining the chemical, physical and mechanical properties of soil, testing soil as a deformable substrate on which land platforms move, but also treated as a mined medium. The curriculum content will include the results of scientific work

Lp.	Item Name	Curriculum content
		on soil modeling and interactions between the ground and the general driving system.
63.	Rheology of lubricating oils	Basics of rheology of viscous liquids. Rheological properties of engine and gear oils and their characteristics. Methods of testing the rheological properties of lubricating oils. Selection of oils in terms of their functionality and minimization of friction resistance. Changes in the rheological properties of engine, gear and hydraulic oils during use and the factors determining them.
64.	Mechatronic sensors	The course prepares students to formulate mathematical models of mechatronic sensors. The lectures present the general principles of mechatronic sensors. The method of measurement, errors and methods of calibration of sensors are discussed. As part of the exercises, PhD students formulate mathematical models of mechatronic sensors. They carry out measurements and determine faults using technologically advanced mechatronic sensors.
65.	Simulation and visualization of system dynamics	The course prepares doctoral students for research using simulation and visualization of the dynamics of mechanical systems. For selected mathematical models of dynamical processes that require the solution of systems of ordinary differential equations. The lectures present general principles for solving the problems of simulation and visualization of dynamics. As part of the exercises, doctoral students simulate the dynamics of systems for selected mathematical models, and in some of the exercises also computer animation.
66.	Control systems in mechanical engineering	Fuzzy logic Hardware configuration of PLCs. Simple logic control tasks IEC 61131-3 – programming languages. Synthesis of the process and control algorithm of the SFC method. GPS control systems
67.	Development trends in automotive technology	Problems of the development of automotive technology and road traffic. Concepts of intelligent transport systems. Development tendencies in the construction of drive and chassis systems. Discussion of selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs). Car occupant safety system and driver assistance systems. Development of vehicle lighting systems. Hybrid, electric, autonomous cars.
68.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
69.	Theory of technical systems	The subject matter of the course includes: basic concepts of the theory of technical systems and general principles of construction and design of technical systems, thermodynamic and informational description of the state of the system, energy and information circulation, estimation of entropy of the system state, energy flow in technical devices, examples of hardware and software solutions of devices
70.	Thermomechanics of materials and studies of thermophysical properties	The aim of the course is to familiarize participants with the phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and to present selected issues of the statistical description of these phenomena to explain the nature of thermo-physical properties. This will allow you to understand the phenomena of heat transfer in materials and material structures and will enable you to learn about the methodology of thermophysical research and methods of thermal analysis.
71.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.
72.	Durability of aircraft structures	The aim of the course is to provide the doctoral student with knowledge on the methods of determining and testing the durability of aircraft. The theoretical part covers the following issues: concepts of aircraft operation, factors limiting the

Lp.	Item Name	Curriculum content
		durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in aircraft operation. The laboratory aims to familiarize doctoral students with selected non-destructive testing techniques, strain gauge measurements and computer calculations of fatigue cycles.
73.	Radioelectronic systems in radar systems	General characteristics of echolocation systems. Tasks of echolocation systems: detection, location, parameter estimation, identification. Methods of detecting echolocation signals. Probability of detection and probability of false alarm. Methods of measuring distances and angles used in the location of objects. Range equation in radar. Object tracking - Kalman filter. Synthetic Aperture Echolocation Systems
74.	Validation of numerical models	Discussion of simulation methods in structural mechanics. Principles of building numerical models of a selected physical process. Verification vs. validation. Planning a numerical experiment in the context of its correctness. Conclusions from numerical validation studies.
75.	Introduction to the equations of mathematical physics	The course prepares students to formulate mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. The lectures present general principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics is presented. The method of reducing borderline issues to a dimensionless form is discussed. As part of the exercises, doctoral students formulate mathematical models based on mathematical physics equations. The seminar is devoted to the presentation by PhD students of the results of projects involving the formulation of mathematical models based on mathematical physics equations
76.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
77.	Selected Technological and Material Aspects of Powder Metallurgy	The course prepares for the implementation of research work in which there is scientific research related to powder metallurgy (MP). The lectures present basic knowledge about sinter technology. The phases of processes (MP), their main parameters and their impact on the final properties of the products are discussed. The starting materials used in the technology and their morphological and granulometric characteristics are presented. New varieties of powder metallurgy processes are discussed, i.e. mechanical alloying and production of nanopowders, as well as examples of the application of powder metallurgy in technology. As part of laboratory exercises, doctoral students learn about the methods of determining selected granulometric parameters of powders and how to perform them and interpret the results obtained.
78.	Selected methods and techniques of temperature measurement	The course prepares students for the correct performance of temperature measurements associated with conducting experimental research. The lectures present the theoretical foundations of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. In particular, the following types of thermometers are discussed: liquid thermometers, thermoelectric thermometers, resistance thermometers, thermistor, quartz, bimetallic, radiation, fiber optic thermometers and thermal imaging cameras. As part of laboratory exercises, doctoral students use the knowledge gained during lectures to independently perform temperature measurements using thermocouples, resistance temperature sensors and a thermal imaging camera. Particular emphasis is placed on the statistical processing of the measurement results
79.	Selected problems of rocket technology	The course prepares students to formulate mathematical models of physical processes related to the dynamics of rocket motion. The lectures present the general principles of rocket construction. The construction of rocket compartments along with mathematical models is discussed. As part of the exercises, doctoral students formulate mathematical models and conduct computer simulation and visualization of the rocket flight path. They determine the overloads of the rockets on the flight path.

Lp.	Item Name	Curriculum content
80.	Selected problems of higher algebra	The course is used to learn the concepts and theorems of algebra relating to basic algebraic structures, vector spaces and linear operators, as well as quadratic and quadric forms, as well as to understand and master transformations related to changes in bases in vector spaces and projections to subspaces in Euclidean spaces.
81.	Selected issues of functional analysis	The course is used to develop the ability to create mathematical models and to pose simple and inverse problems of mathematical physics in variational or optimization forms, and to learn methods of approximate solving of such correctly and incorrectly posed problems.
82.	Selected issues of safety and ergonomics of vehicle crews	Contemporary threats of military vehicles. Standards and regulations for vehicle crew survival – parameters. Propagation of pressure pulses. Numerical methods used to assess the safety of vehicles and their crews.
83.	Selected issues of structural dynamics	Analysis of the pressure impulse load on the structure. Verification of FEM results analytically. Approximate methods for the evaluation of the results obtained.
84.	Selected Issues of Mechanics of Continuous Media	Elements of thermomechanics, elastic waves in continuous media, shock waves, explosion mechanics.
85.	Selected issues of active defence of military vehicles	The course will present the requirements for modern, complex systems on the example of an active vehicle defense system. Physical phenomena used in this type of interdisciplinary systems will be discussed, with particular emphasis on the mechanical part of the systems in question. Experimental studies of materials and methods of their modeling, as well as studies of the entire system will be presented. Methods of modeling selected effectors will be discussed.
86.	Selected issues of modern programming	Introduction to the object-oriented programming paradigm. Intermediate code and runtime issues. Introduction to C# and Microsoft Visual Studio. Create console programs using C# and Microsoft Visual Studio. Introduction to Python. Creating programs based on selected algorithms.
87.	Strength of adhesive joints	Mechanical and physical properties of macromolecular plastics. Theories of adhesion. Technologies for constituting adhesive bonds. Analysis of the strength of adhesive joints. Strength optimization of adhesive joints
88.	Fatigue Strength and Fracture Mechanics	General characteristics of fracture mechanics. Griffith's theory of brittle fracture, elements of linear fracture mechanics. Ductility in the fracture zone. Force fracture criterion. Material fatigue phenomenon. Strength and fatigue life, Wöhler, Smith, Haigh charts. Propagation of fatigue cracks. Modeling of cracks and determination of the quantities determining their development. Calculation of fatigue life based on fracture velocity. Probabilistic Methods of Fatigue Calculations
89.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Application of the principles of fatigue strength of materials and fracture mechanics in the operation of structures. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Fatigue test methodologies and fatigue testing equipment.
90.	Advanced methods of manufacturing products from sintered powders	The subject matter of the course allows you to learn about the processes of manufacturing machine parts using modern methods of manufacturing engineering, including powder metallurgy.
91.	Advanced ballistics, modeling, and simulation	During the course, students will learn about the methods of analysis, research and modeling of advanced ballistics phenomena and use practically learned modeling methods to analyze selected phenomena of internal, external or final ballistics.
92.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
93.	Advanced Materials	The subject matter of the course allows you to learn about the structure, properties and technology of obtaining semiconductors (silicon, GaAs, blue optoelectronics nitrides, silicon carbide, solid solutions with HgCdTe, graphene) and low-dimensional quantum structures used in the construction of photonic sensors of the optical range. The presented examples of applications of these materials are the most spectacular achievements of sensor technology in the military, industrial

Lp.	Item Name	Curriculum content
		equipment, security systems and medicine. The part of the course covering construction materials concerns the properties of classic superalloys and intermetals and selected special alloys such as: ADI cast iron, steel (duplex and maraging), as well as ceramic and composite materials as well as diffusion and adhesive surface layers modified by thermo-chemical treatment and produced by CVD and PVD methods, by ion implantation and thermal spraying with supersonic metallization flux flow. It determines the knowledge of the basics of the structure of these materials, the ability to analyze the structure and mechanisms of phase transitions, as well as the ability to make structural changes and assess their performance based on the technological processes of their production. It introduces the types of research used in the experimental analysis of structure and mechanical properties. It indicates the use of engineering materials of special importance in technology. The practical element is the acquisition of the ability to assess the use of a given type of material with specific properties in engineering design.
94.	Advanced Material Modeling	Modern ceramics, ceramic composites, residual stress problem, gradient materials, modeling of material structures, statistical analysis of FEM calculation results.
95.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
96.	Advanced measurement systems	The course allows you to learn about the structure and organization of computer-controlled measurement systems as well as the procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. In practical terms, they allow you to master the basics of programming and how to use virtual instruments to collect, collect and process measurement data.
97.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
98.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
99.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	The course will present issues related to the propagation of waves (elastic, plastic). A mathematical description will be presented to analyze the presented issue, as well as boundary conditions. Then, methods to solve the presented issue will be briefly characterized. On selected examples, the analysis of wave propagation will be shown.
100.	Material and structural fatigue	The classes are aimed at providing the doctoral student with knowledge in the field of material fatigue and teaching the practical use of tools for computer-aided analysis. The theoretical part covers the following issues: basics of fatigue of materials, low- and high-cycle fatigue, S-N curve, hypotheses of fatigue damage accumulation, correction of average stresses, analysis of load spectra, planning and conducting fatigue tests. The exercises will cover the practical elements of durability analysis, which can be performed using simple analytical calculations. The laboratory aims to familiarize doctoral students with engineering software enabling fatigue analyses.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

Lp.	Item Name	Curriculum content
1.	Analysis of Chemical Warfare Agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and technology of liquid crystal materials	The subject covers the molecular structure, structure and texture of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and technology of high-energy materials	The course includes the presentation of the current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels. Lectures and laboratory classes concern in particular: (i) structural determinants of the stability and sensitivity of explosive compounds; (ii) design, fabrication and characterisation of nanostructured explosive mixtures; (iii) principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; (iv) new ways of producing explosive compositions and forming them into charges; (v) design, manufacture and characterisation of thermobaric explosives; (vi) design, synthesis and explosive properties of complex compounds; (vii) design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids, and (viii) new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Electroanalysis	Basics and classification of electrochemical methods of analysis. Potentometry. Electrogravimetry. Coulometry. Polarography. Volammetry. Conductometry. Amperometric titration. Capillary electromigration techniques - apparatus for capillary electrophoresis and the principle of separation of mixture components. Capillary isotachophoresis (CITP). Micellar Electrokinetic Chromatography (MEKC). Capillary gel electrophoresis (CGE). Capillary Isoelectric Focusing (CIEF). Capillary electrochromatography (CEC). Overview of the application of electrochemical methods in practice.
5.	Physics and chemistry of carbon materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and bioactivity of carbon materials. Prospects for the development of new carbon structures and their applications.
6.	Physicochemical aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
7.	History of chemistry	The students will be introduced to the broadly understood roots of modern chem-

Lp.	Item Name	Curriculum content
		istry. At the beginning, the synthesis of elements in the universe will be discussed, followed by the first observations and chemical achievements of antiquity (alchemy). The history of chemical discoveries in the world will be presented chronologically, taking into account the contemporary division of scientific fields such as physical chemistry, analytical chemistry, chemical analysis, organic synthesis, food chemistry. Particular emphasis will be placed on the achievements of chemistry after 1661 (R. Boyl). The development of techniques for separation of substances and analysis and their impact on the development of views on chemistry and the structure of chemical compounds will be presented. The evolution of nomenclature and symbols of elements and chemical compounds will be discussed. The history of the periodic table of Mendeleev, kinetic and thermodynamic studies will be presented. Particular emphasis will be placed on the rapid development of organic chemistry and synthesis in the 20th century and its impact on the emergence of molecular biology.
8.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
9.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
10.	Spectroscopic methods	Expanding the knowledge on spectroscopic methods for PhD students in the discipline of chemical sciences. Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Modern spectroscopic methods.
11.	Latest trends in electrochemistry	Modern models of the double electrical layer (EDL). Voltammetric techniques. Currently used materials and designs of working electrodes. Electrochemical Impedance Spectroscopy (EIS) and its applications. New fuel cell designs, biofuel cells, coal-powered cells, construction. New electrocatalytic circuits, applications. The latest types of lithium-ion batteries. Lithium-sulfur batteries. Application of intercalation in electrochemistry. Electrochemical capacitors (EDLC), construction. Ionic liquids (ILs). Application of carbon materials in electrochemistry. Electrochemical methods for surface modification of solids. Electropolymerization. Conductive polymers.
12.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Adsorption of nitrogen and argon as a complete method for determining the specific surface area, porosity and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and investigation of adsorption properties of graphene composite materials. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
13.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals – introduction, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic

Lp.	Item Name	Curriculum content
		materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials
14.	Signal Processing in Analytical Chemistry	Basic methods of processing the analytical signal. Spectra obtained from measuring instruments used in analytics. Big data processing. Multivariate data obtained from combined measurement techniques. Search for analytical information contained in large data sets. Elements of chemometrics. Principal components method. Similarity analysis. Presentation of measurement data in scientific publications.
15.	Synthesis of liquid crystals	Introduction to liquid crystals, structure and anisotropic properties. Applications of liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Super fluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
16.	Introduction to Spectroscopy	Basic knowledge of spectroscopic methods for PhDs in disciplines other than chemical sciences. Two versions of the item are possible. Standard version: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Individual version in accordance with the interests of the PhD student, extending selected spectroscopic methods from the given group of methods: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). Oscillation-rotational and rotational spectroscopy. One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Circular dichroism spectroscopy (ECD and VCD). Mass spectrometry (MS).
17.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
18.	Advanced pyrotechnics	The students will be familiarized with the latest solutions used in military and civilian pyrotechnics. Contemporary reducers, oxidants, binders and modifiers will be discussed. Pyrotechnic applications of high-nitrogen compounds will be presented. Modern compositions of curtain smoke active in the infrared range will be discussed. Students will be introduced to modern multi-base solid rocket fuels. The solutions used in airbag inflators will be discussed. Prospective applications of pyrotechnic mixtures in medicine will be presented. The basic algorithms used in the modeling of combustion processes and analytical optimization of the composition of pyrotechnic compositions will be discussed.
19.	Application of gas chromatography in physicochemical studies	The essence of interactions in chromatography. Mechanisms of chromatographing test substances. Basic chromatographic quantities. State functions – methods of calculation and interpretation. Study of the physical transformations of pure substances. Phase stability and phase transitions. Study of surface properties and basic surface phenomena. Methods of surface determination and analysis.

Annex VI.7
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security sciences

Lp.	Item Name	Curriculum content
1.	Social research in security sciences	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Desk *research.*
2.	Information security	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPuugula, Biba, Clark-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
3.	Evaluation of security system processes and designs	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
4.	Geography, Geospatial Information Systems in Crisis Management	Identification of the needs of geoanalyses in the CMS. The essence of GIS systems. Functional components of GIS systems. Feature geospatial attribute location and description systems. Mechanisms for imaging and visualization of objects. Comprehensive monitoring of facilities and threats in the CMS. Threat analysis models and tools from a geospatial perspective.
5.	Systems Research Methodology	The genesis of holistic-systemic concepts. Evolution of the holistic-systemic paradigm. Applications of systems analysis, RAND experience. Evaluation of dual-use technologies. Modeling of security systems
6.	International Military Relations	International systems, world history, and the theory of military relations (presentism, ahistoricism, Eurocentrism, anarchophilia, state-centrism, alternative). Systems thinking about international military relations (ability to interact, process, structure). Analysis levels and dimensions. Military-political trials. Ability to interact in the modern international system. Perspectives – a post-modern system of international military relations.
7.	Problems of the information society	Information civilization, information culture, information society. Models of development and constitutive features of the information society. Security of the cyberspace of the state. The information society as a risk society.
8.	Strategies and concepts of state security management	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal-functional factors and ways of defining security in doctrines and strategies (comparative analysis).
9.	Security theory	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies "Old" and "new" wars in the interpretations of realism and constructivism.
10.	Modern information warfare	Evolution of conflicts. Technical determinants, technological revolutions and their impact on the wars of the postmodern world (infowar, net war, cyberwar). Information warfare in the doctrines of selected countries, comparative analysis. Information warfare scenarios, risk analysis. Future studies: models, forecasts
11.	Geopolitics and geostrategy in the modern world	Terminology, analyses and forecasts of international security based on the terminological and methodological workshop of geopolitics and geostrategy. Defining geopolitics and geostrategy and the main assumptions adopted in the characterization of international reality along with the development of forecasts of the development of the situation in individual regions of the world and in the global dimension on the basis of these characteristics.
12.	Economic security in the face of information and post-industrial changes	Definition of information, industrial and post-industrial society. The impact of contemporary economic changes on the security of selected countries. To indicate the connotations between the civilizational evolution from the industrial society to

Lp.	Item Name	Curriculum content
		the informational-post-industrial society, along with the effects on the security of selected countries caused by this evolution, mainly depending on the civilizational advancement of a given country/society.
13.	Military security in the 21st century: opportunities, challenges, threats	Characteristics of military security of selected states and associations of states in relation to the methodology of identification and description of challenges, and thus potential opportunities and threats to the existence and development of individual societies. The terminology of military security, the components of this security, the impact of these elements on the state and process of military security in the face of identified and described challenges (opportunities and threats) in the perspective of the current century.
14.	Environmental security on a global, regional and national scale	Types of challenges (opportunities and threats) generated by climate change in the area of environmental security. Identification of the impact of climate change on the national security of selected societies on a national, regional and global scale.
15.	Energy security of countries in the face of socio-economic transformation	The impact of socio-economic transformation on the functioning of the energy sector of developing and developed countries, and thus also on the energy security of these countries. Discussion of the parallel process of influencing the way the energy industry operates, as well as the functioning of the energy security sector to protect this industry against threats (both old and new, generated by current socio-economic changes).
16.	Forecasting of international threats: methods, techniques and tools	Discussion and verification of the effectiveness of existing methods, techniques and forecasting tools, including the division into quantitative and qualitative methods, in order to use mixed methods in the further part of the course. Checking not only the effectiveness of existing methods, but also their reliability as elements of the methodological workshop in security sciences.
17.	Culture of security in national and international relations	Presentation of definitional approaches to security culture with the use of approaches and interpretations functioning on its basis in the interpretation and characteristics of events occurring in the space of national and international security.

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology

No. 25/WAT/2023 of 23 February 2023

amending the resolution on the establishment of the "Curriculum of education at the Doctoral School of the Military University of Technology"

Pursuant to § 21(1)(21) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is hereby resolved:

§ 1

The following changes are made to the Curriculum of the Doctoral School of the Military University of Technology, which is an annex to the Resolution of the Senate of the Military University of Technology No. 124/WAT/2020 of 27 February 2020 on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology":

1) the words *'automation, electronics and electrical engineering'* are replaced by the words *'automation, electronics, electrical engineering and space technologies'*;
2) the words "civil engineering and transport" shall be replaced by the words *"civil engineering, surveying and transport".*

§ 2

The resolution enters into force on the day of its adoption, with effect from 11 November 2022.

President of the Senate

/--/ Brig. Gen. Prof. Przemysław Wachulak

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 8/WAT/2021 of 25 February 2021

on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology"

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended), in connection with § 21(1)(21) of the Statute of the Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019), the following is resolved:

§ 1

The "Education program at the Doctoral School of the Military University of Technology" *is hereby established,* constituting an attachment to the resolution.

§ 2

The curriculum referred to in § 1 is in force from the academic year 2021/2022.

§ 3

Doctoral students of the Doctoral School of the Military University of Technology who started their education before the academic year 2021/2022 may update their Individual Education Programmes on the basis of this programme.

§ 4

The resolution shall enter into force on the date of its adoption.

President of the Senate

/--/Col. Professor Przemysław Wachulak, PhD, DSc, Eng.

Attachment to the Resolution of the Senate of the Military University of Technology No. 8/WAT/2021 of 25 February 2021

CURRICULUM

AT THE DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

I. General principles

1. The curriculum at the Doctoral School of the Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics and electrical engineering** - a field of engineering and technical sciences;
    2) **technical informatics and telecommunications** - a field of engineering and technical sciences;
    3) **civil engineering and transport** - a field of engineering and technical sciences;
    4) **materials engineering** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security sciences** - a field of social sciences;
    7) **Chemical sciences** - a field of exact and natural sciences.
2. The learning outcomes take into account the requirements specified for level 8 of the Polish Qualifications Framework.
3. Number of semesters: **8**
4. Number of ECTS credits – min. **30 points**
5. The number of compulsory courses is 100 hours and 20 hours of practical training carried out in the form of conducting classes or participating in them and corresponds to a total of 10 ECTS credits, and the number of optional courses is at least 200 hours and corresponds to at least 20 ECTS credits**.** Optional courses may include classes in subjects carried out at MUT from the optional module, courses taught at another university or scientific institution in Poland or abroad, and other forms of education, e.g. internships, internships at and outside the Military University of Technology, in particular at another university or scientific institution in Poland or abroad.
6. Language of conducting:
    a. **Polish or English –** only in the case of subjects, internships or other forms of education indicated in the Individual Education Programme (IPK),
    b. **English –** in the case of education in a scientific discipline in English.
7. The program is valid from: **academic year 2021/2022.**
8. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:
   Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is the professional preparation of future staff in the fields of engineering and technology, exact and natural sciences and social sciences, in particular in the field of military technology and security technology. The task of the Doctoral School is to provide doctoral students with the latest knowledge, shape skills and improve competences at the highest level, as well as cultivate patriotic traditions and responsibility for the Homeland in broadly understood aspects, both military and civilian, in accord-

ance with the principle "Omnia Pro Patria" – "Everything for the Homeland". The activities of the Doctoral School correlate with the strategic objectives of the Academy's development in terms of strengthening the position of the Military University of Technology in the system of Polish and European higher education, including as the leading educational pillar of higher military education and the expert and research base of the Ministry of National Defense, as well as other ministries. In addition, it emphasizes the elite nature of the Academy as a university conducting innovative teaching and scientific activities, also developing international cooperation in this field.

9. Prerequisites for the candidate for the Doctoral School

   The candidate should have qualifications at level 7 of the Polish Qualifications Framework (Master's degree, Master's degree in engineering or equivalent) and have completed a Master's degree in a field related to the scientific discipline conducted at the Doctoral School. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may admit a person who is a graduate of first-cycle studies or a student who has completed the third year of uniform master's degree studies. Detailed requirements are set out in the rules of recruitment to the Doctoral School established by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for subjects for which the university learning outcomes are required;
2) in the code column - reference of the assumed learning outcome to the appropriate code of the component of the description of the first- and second-cycle characteristics of learning outcomes at level 8 of the Polish Qualifications Framework (PQF 8).
3)

Effect number symbols	**Expected learning outcomes**	**code description component**
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific disci-*	*P8U_W*

Effect number symbols	Expected learning outcomes	code description component
	pline and the resulting implications for practice	*P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
Skills: the graduate is able to		
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK* *P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8U_U* *P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8U_U* *P8S_UW*
D_U03	*independently plan and act for their own development and inspire and organize the development of others,*	*P8U_U* *P8S_UU*
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and object of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8U_U* *P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8U_U* *P8S_UK*
D_U10	*participate in scientific discourse, exchange of experiences and ideas, also in the international environment*	*P8U_U* *P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*
D_U13	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*
	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_K*

Effect number symbols	Expected learning outcomes	code description component
		P8U_KK
D_K02	*taking into account the challenges in the professional and public sphere, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_K* *P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8U_K* *P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8U_U* *P8S_KK*
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8U_U* *P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8U_U* *P8S_KO*
D_K07	*initiating activities in the public interest*	*P8U_U* *P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8U_U* *P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including:* *− conducting scientific activity in an independent manner,* *− respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8U_U* *P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- completion of courses included in the Basic Module, including a doctoral seminar in the subject Analysis of the research area,
- completion of courses from the Optional Module of a discipline or scientific disciplines, professional practice and subjects carried out outside the Military University of Technology and other forms of education[1] included in the Individual Education Program (IPK);
- positively assessed by the supervisor of the doctoral dissertation.

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.
2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.
3. The curriculum includes at least 300 hours of classes[2] and at least 20 hours of professional internships in the form of conducting classes or participating in them - at least 30 ECTS credits in total.

[1] if they appear in IPK

[2] classes may include courses taught outside the Military University of Technology and other forms of education

4. The doctoral student's education program consists of:
    1) the basic module for doctoral students of all scientific disciplines conducted at the Doctoral School, 100 hours with a total of 9 ECTS credits;
    2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned, subject to sections 6, 7 and 8;
    3) 20 to 180 hours of practical training in the form of classes or participation in classes from the third to the seventh semester of education – max. 60 hours per year (in accordance with an individual curriculum), which are assigned 1 ECTS credit, regardless of the number of hours of practical training.
    4) optionally, courses taught outside the Military University of Technology and other forms of education on an hourly basis and the number of ECTS credits specified in an individual curriculum.
5. A doctoral student is required to complete the basic module and 20 hours of professional practice in the form of conducting classes or participating in them. A doctoral student, in consultation with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. It is allowed for courses to come from different scientific disciplines and to be taught at another university or research institution.
6. In the case of planned courses outside the Military University of Technology and other forms of education (e.g. internships, internships at and outside the Military University of Technology), the supervisor determines the number of ECTS credits and the learning outcomes to be achieved, provided that the number of hours of classes in the optional module cannot be less than 100 hours and 10 ECTS credits. The number of ECTS credits for a semester of internship or internship may not exceed 5 credits.
7. In the case of education for foreigners in English, the subjects included in the basic module referred to in Chapter V, concerning the issues of Polish regulations, may be replaced by other subjects. Decisions on the introduction of new subjects are made by the Director of the Doctoral School in consultation with the Chairman of the Scientific Discipline Council, within which the education of foreigners is conducted.
8. The implementation of the education programme, taking into account the provisions of sections 5-7, should ensure that the candidate achieves the assumed learning outcomes specified in Chapter II.
9. By the end of the first semester of education, the doctoral student submits an individual education program to the director of the Doctoral School, agreed with the supervisor.
10. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year, subject to paragraph 11
11. Classes for foreigners pursuing education in English are planned as part of the scientific discipline, including the subjects referred to in paragraph 7.
12. Classes in the subjects of the optional module are planned on an individual basis according to individual curricula.

13. Classes are held in accordance with the education plan (general and individual) and are carried out according to the semester timetables in force at the Academy.

V. Modules of the curriculum

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, obligatory for doctoral students of all disciplines[3] (I-II sem.)				
1.	Higher education	20	1	*D_WWAT01, D_W05, D_W06, D_UWAT01, D_U03, D_K01, D_K02*
2.	Rules for conducting classes	10	1	*D_WWAT01, D_UWAT01, D_U03, D_U13, D_K01, D_K06*
3.	The process of applying for research funding	10	1	*D_K01, D_K03.D_K04*
4.	Organizational, legal and ethical aspects of scientific work. Self-presentation of a scientist.	10	1	*D_W06, D_U12,*
5.	Methodology of conducting scientific research	10	1	*D_WAT02, D_U01-U05*
6.	Ownership and commercialisation of research	10	1	*D_W05, D_W06,D_U06*
7.	Scientometrics and bibliometrics in scientific activity	4	1	*D_W05, D_U08, D_K03, D_K04*
8.	Principles of writing a scientific paper	6	1	*D_W05, D_W06, D_U07*
9.	Analysis of the research area[4]	20	1	*D_W01, D_W02, D_W03, D_W4, D_U08*
Optional modules related to the scientific discipline (III-VII sem.)				
1	Automation, Electronics & Electrical Engineering	min. 200 hrs[5]	min. 20 points	*List of items attachment V.1 - page 11*
2	Informatics and Telecommunications			*List of items attachment V.2 - p. 13*
3	Civil Engineering and Transportation			*List of items attachment V.3 – p. 15*
4	Materials Science			*List of items attachment V.4 - page 16*
5	Mechanical Engineering			*List of items attachment V.5 – page 18*
6	Chemical Sciences			*List of items attachment V.6 – p. 21*
7	Security Sciences			*List of items attachment V.7 - p. 22*
Internships at WAT (III-VII sem.) - in accordance with the individual education program				
1	Internships in the form of conducting classes or participating in them	20-180 hours	1	*D_WWAT01, D_UWAT01 D_K01*
Subjects taught outside the Military University of Technology and Other forms of education (III-VII sem.) **-** Optionally according to the individual training program				
1	Subjects outside MUT and, for example, internships, internships carried out at and outside MUT at another university or scientific institution in Poland or abroad	*The number of hours, ECTS credits and reference to learning outcomes is determined by the supervisor in an individualised learning programme*		

[3] in the case of education for foreigners in English, the subjects included in the basic module, concerning the issues of Polish regulations, may be replaced by other subjects determined by the Director of the Doctoral School.

[4] course carried out on an individual basis with a supervisor or supervisor and assistant supervisor completed with a doctoral seminar

[5] the minimum number of hours in an optional module may be reduced by pursuing other forms of education, the sum of ECTS credits for an optional module and other forms of education may not be less than 20 points, while maintaining at least 100 hours of an optional module

VI. Framework Programme

The framework programme includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

Lp.	Name Item /discipline Scientific	Curriculum content
Basic module, compulsory for all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Policy conducting classes	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	Process Inference for financing Research	The process of applying for funding for basic scientific research. Statutory activities, financing of domestic and foreign scientific internships for young scientists starting their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Education and Science, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Organizational legal and ethical aspects of work Scientific. Self-presentation Researcher.	Organization of research activities at the university on the example of the Military University of Technology. A model of scientific career in Poland. Parametric evaluation of an academic teacher and a research unit (discipline). Foreign internships and scholarships as part of a scientific career. Formal and substantive activities for the implementation of the doctoral dissertation. Principles of ethics in scientific research and in scientific careers. Principles of self-presentation during the defense of the doctoral dissertation and in the scientific career.
5.	Methodology Conduct research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that requires a solution – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6.	Proprietary Rights and commercialization Research	Basic information on the methods of intellectual property protection, in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection. Issues of commercialization of the results of scientific research and development works.
7.	Scientometrics I Bibliometrics in the activity Scientific	Scientometric and bibliometric indicators used in international bibliographic databases (Scopus, WoS), as well as national requirements related to the evaluation of researchers. Dissemination of scientific activities and research results, with particular emphasis on open access policy. The use of bibliographic databases and e-sources in scientific research. Tools supporting the collection of materials supporting the writing of scientific papers.
8.	Writing rules scientific work	Types of doctoral dissertations, requirements for doctoral dissertations, structure of a doctoral dissertation, edition of a doctoral dissertation, examples of doctoral dissertations, examples of reviews of doctoral dissertations.

Lp.	Name Item /discipline Scientific	Curriculum content
9.	Area Analysis Research	Seminar classes supervisor – PhD student. Analysis of the state of knowledge in the field of research issues selected by the doctoral student. Literature review. Defining the research problem (goal, research questions, hypotheses) and preliminary determination of the methodology. Preparation of a presentation for the first doctoral seminar.
Optional modules related to the scientific discipline		
1	Automation, Electronics & Electrical Engineering	*Annex VI.1 – page 24*
2	Informatics and Telecommunications	*Annex VI.2 – page 32*
3	Civil Engineering and Transportation	*Annex VI.3 – page 41*
4	Engineering Material	*Annex VI.4 – page 45*
5	Engineering Mechanical	*Annex VI.5 – page 50*
6	Chemical Sciences	*Annex VI.6 – page 57*
7	Security Sciences	*Annex VI.7 – page 60*

VII. Organisation of apprenticeships and other forms of education

Apprenticeships are carried out in the form of teaching classes or participation in their conduct. From the third to the seventh semester of education, a doctoral student is obliged to conduct classes or participate in conducting them for a minimum of 20 hours.

In special and justified cases (e.g. disability of a doctoral student), the supervisor may exempt a doctoral student from the obligation to undergo professional practice by indicating an additional optional subject or another form of education in the amount corresponding to the number of ECTS credits for professional practice.

It is allowed to carry out other forms of education from the third to the seventh semester of education, i.e. internships (other than teaching classes or participating in their conduct), internships in and outside the Military University of Technology, m.in. at a university, a domestic or foreign scientific institution, enterprises whose scope of activity is related to the subject of the doctoral dissertation. Other forms of education, their number of hours and the allocation of ECTS credits are decided by the supervisor in the Individualised Education Programme.

Apprenticeships and other forms of education are subject to credit for the descriptive grade (*zal / nzal*) in the academic year in which they took place in accordance with the rules set out in the Regulations of the Doctoral School of the Military University of Technology.

VIII. Educational plan

The education plan consists of a general part for all doctoral students of the year, and an individual education plan for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

The Individual Education Plan for Doctoral Student Semesters III to VIII is created on the basis of the Individual Education Programme. It is recommended that the semester workload of the doctoral student should be even - at the level of 5 ECTS points.

PLAN KSZTAŁCENIA W SZKOLE DOKTORSKIEJ
WSZYSTKIE DYSCYPLINY NAUKOWE PROWADZONE W SZKOLE DOKTORSKIEJ

	moduły/*przedmioty*	ogółem godzin/ pkt ECTS		liczba godzin/pkt ECTS w semestrze:													
				I		II		III		IV		V		VI		VII	VIII
		godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS
Moduł podstawowy, obowiązkowy dla wszystkich dyscyplin																			
	Ogółem	**100**	**9**	**50**	**3**	**50**	**6**												
1	**Dydaktyka szkoły wyższej**	**20**	**1**	**20**	**1**														
2	**Zasady prowadzenia zajęć dydaktycznych**	**10**	**1**	**10**	**1**														
3	**Proces wnioskowania o finansowanie badań naukowych**	**10**	**1**			**10**	**1**												
4	**Organizacyjne, prawne i etyczne aspekty pracy naukowej. Autoprezentacja naukowca.**	**10**	**1**			**10**	**1**												
5	**Metodologia prowadzenia badań naukowych**	**10**	**1**			**10**	**1**												
6	**Prawa własności komercjalizacja badań naukowych**	**10**	**1**			**10**	**1**												
7	**Zasady pisania pracy naukowej**	**6**	**1**			**6**	**1**												
8	**Naukometria i bibliometria w działalności naukowej**	**4**	**1**			**4**	**1**												
9	**Analiza obszaru badawczego**	**20**	**1**	**20**	**1**														
Moduły fakultatywne związane z dyscypliną naukową - 293 przedmioty																			
1	**Automatyka, elektronika i elektrotechnika - 58 przedmiotów**	**min. 200 godz.***	**min. 20 pkt ECTS***					**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
2	**Informatyka techniczna i telekomunikacja - 41 przedmiotów**																		
3	**Inżynieria lądowa i transport - 28 przedmiotów**																		
4	**Inżynieria materiałowa - 35 przedmiotów**																		
5	**Inżynieria mechaniczna - 79 przedmiotów**																		
6	**Nauki o bezpieczeństwie - 31 przedmiotów**																		
7	**Nauki chemiczne - 21 przedmiotów**																		
Praktyki zawodowe																			
1	*Praktyki zawodowe w formie prowadzenia zajęć lub uczestnictwa w ich prowadzeniu*	**20-180**	**1**					**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
Przedmioty realizowane w innej uczelni lub instytucji naukowej krajowej lub zagranicznej - opcjonalnie zgodnie z IPK																			
1	*Przedmioty realizowane w formie bezpośredniej i zdalnej*	***zgodnie z IPK***						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
Inne formy kształcenia - opcjonalnie zgodnie z IPK																			
1	*np. praktyki, staże realizowane w i poza WAT, w innej uczelni lub instytucji naukowej krajowej lub zagranicznej*	***zgodnie z IPK***						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											

** Suma punktów ECTS w ramach IPK musi wynosić min. 21 punktów, min. liczba godzin w Module fakultatywnym może być zmniejszona do 100 godz. i 10 pkt. poprzez realizację przedmiotów poza WAT i innych form kształcenia, którym przyporządkowano liczbę godzin i punktów ECTS*

IX. Internal system for ensuring the quality of education at the Doctoral School

The internal education quality assurance system at the Doctoral School is an element of the Education Quality Assurance System at the Military University of Technology.

As part of the preparation of doctoral students for high-level research work, the importance of continuous monitoring and systematic improvement of the quality of their education increases. The education quality policy, resulting from the mission and development strategy of the Academy, is implemented at the Academy by setting appropriate goals and quality standards, as well as by implementing, continuously monitoring and improving the internal quality assurance system.

The scope of the internal education quality assurance system at the Doctoral School includes in particular:

1) monitoring and analysis of the formal and legal side of the teaching process;
2) periodic review and updating of education programs;
4) analysis of the conditions for the implementation of the teaching process;
5) monitoring factors affecting the quality of education;

6) analysis of the functioning and development of methods for improving the quality of education.

Annex V.1

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Administration of computer networks II	20	3	*D_W03*
2.	Computer-aided analysis of experimental data	30	3	*D_W03, D_U06*
3.	Smart Antennas	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
4.	Digital Image Processing	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
5.	Optical Radiation Detectors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
6.	Electromechanical energy and signal converters	30	3	*D_W01, D_U05*
7.	English for electronics	20	2	*D_W03, D_U04, D_K01*
8.	Laser Physics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
9.	Physics of laser media	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
10.	Photovoltaics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
11.	Functionalised optoelectronic nanomaterials	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
12.	Supercontinuum Radiation Generation	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
13.	Imaging Information Engineering	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
14.	Encoding and recognition of radio transmissions	30	3	*D_U05*
15.	Crystallography	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
16.	Laser absorption spectroscopy in gas sensors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
17.	Laser-plasma radiation sources X-ray and extreme ultraviolet (EUV)	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
18.	Lasers for medical applications	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
19.	Pico- and femtosecond lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
20.	Fiber lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
21.	Mathematical models of the electromagnetic field	20	2	*D_W02, D_W03*
22.	Finite Element Method	30	3	*D_W02, D_W03*
23.	Methods of analysis and measurement of random signals	30	3	*D_W02, D_U05*
24.	Data mining methods and tools	30	3	*D_W02, D_W04*
25.	Numerical methods	30	3	*D_W01, D_W03*
26.	Methods of logical synthesis	30	3	*D_W02, D_W03*
27.	Surveying and optoelectronic measurements	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
28.	Modeling of physical phenomena and processes	30	2	*D_W01, D_W02, D_W03 D_U04, D_K03, D_K05*
29.	Nonlinear Laser Conversion	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
30.	Scientific and engineering calculations	30	3	*D_W04*
31.	Optoelectronics in safety systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
32.	Laser optics	30	2	*D_W01, D_W02, D_W03*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
				D_U010, D_K03, D_K05
33.	Coherent Light Optics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
34.	Plasma in science and technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
35.	Remote Sensing Basics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
36.	Designing safety systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
37.	Programmable and Purpose-Built Circuits	30	3	*D_W01, D_U05*
38.	Selected problems of digital signal processing	30	3	*D_W01, D_W03*
39.	Acoustic sensors	20	2	*D_W04, D_W05*
40.	Microwave sensors in radiolocation	20	2	*D_W02, D_U04*
41.	Smart radio networks	30	3	*D_W01, D_W03*
42.	Optical Spectroscopy for Life Sciences	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
43.	Digital systems in optoelectronic devices	30	2	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*
44.	Test and measurement systems in the test laboratory	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
45.	Fiber optic technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
46.	Terahertz technique	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
47.	Information concealment technique (steganography)	30	3	*D_W01, D_W02, D_U05*
48.	Thin film technologies	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
49.	Field theory	30	3	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
50.	Thermal imaging and infrared technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
51.	Optical Radiation Detection Systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
52.	Modern transducers measuring physical quantities	30	3	*D_W01, D_U05*
53.	Selected issues of the operation of anthropotechnical systems	30	3	*D_W08, D_U05 i 06*
54.	Selected issues of vibration theory	20	2	*D_W02*
55.	Selected issues in acoustoelectronics	30	3	*D_W04, D_W05*
56.	Advanced microelectronics technologies	30	3	*D_W01, D_U05*
57.	Applications of lasers in technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*
58.	Advanced techniques for digital system design in FPGAs	30	3	*D_W02, D_W03, D_U07, D_U09, D_K05*

Annex V.2

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: technical informatics and telecommunications

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Quantum Algorithms III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
2.	Algorithm Analysis III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
3.	Analysis and synthesis of visual information III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
4.	Next-generation wireless systems (NG)	20	2	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*
5.	ICT Systems Diagnostics III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
6.	Efficiency of ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
7.	Elements of forecast theory III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
8.	Software Evaluation III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
9.	Physical Foundations of Quantum Information III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
10.	Computer Graphics III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
11.	Software Quality Engineering III	20	2	*D_W01,D_W02,D_W03,D_U01 ,D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
12.	Cryptology III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
13.	Mathematical Methods of Decision Support III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
14.	Discrete Mathematics III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
15.	Generative and aspective methods in manufacturing software III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
16.	Numerical methods III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
17.	Multi-Criteria Optimization Methods III	20	2	*D_W01,D_W02,D_W03,D_U01 ,D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
18.	Mathematical Modelling III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
19.	Modeling and verification of ICT networks III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
20.	Modeling human-computer interaction III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
21.	Modeling Conflict Situations III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
22.	Process modeling, simulation and analysis	20	2	*D_W01,D_W02,D_W03,D_U01*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
	Business Enterprises III			*D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
23.	Software Reliability III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
24.	Reliability of Systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
25.	Optimization III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
26.	Probabilistic III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
27.	Stochastic Processes III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
28.	Image Recognition and Processing III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
29.	Neural networks and fuzzy logic III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
30.	Smart radio networks	20	2	*D_W01, D_W03,D_U010, D_K03, D_K05*
31.	Stochastic Exploitation Models III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
32.	Computer Simulation III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
33.	Database Systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
34.	ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
35.	Decision support systems III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
36.	Artificial Intelligence III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
37.	Theoretical foundations of computer science III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
38.	Graph and Network Theory III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
39.	Project and Process Management III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
40.	Complex Data Structures III	20	2	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05,D_U07, D_K01,D_K03*
41.	5G network application for military	30	3	*D_W01,D_W02,D_W03,D_U01 D_U02,D_U04,D_U05*

Annex V.3

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: civil engineering and transport

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Safety and reliability of building structures	20	3	*D_W03; D_W05; D_U02; D_K02*
2.	Dynamic interaction of building structures with a soil medium	20	2	*D_W02; D_U01; D_K05*
3.	Environmental physics	20	2	*D_W03; D_U04; D_K02*
4.	Modeling of thermal and humidity processes	20	2	*D_W03; D_U04; D_K03*
5.	Identification of loads and structural systems	20	2	*D_W02; D_U02; D_K02*
6.	Investment process in the construction industry	20	2	*D_W01; D_U04; D_K05*
7.	Mechanics of road and airport runway soil foundations	20	3	*D_W03; D_U02; D_U04; D_K03*
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	20	2	*D_W03; D_U07; D_K07*
9.	Design methods for folding bridge structures	20	2	*D_W03; D_U01; D_U03; D_K01*
10.	Design methods of the experiment	20	3	*D_W02; D_U01; D_K01*
11.	Modeling the behavior of elements and structures reinforced concrete	20	2	*D_W02; D_U01; D_K01*
12.	Geometric and physical nonlinearities in mechanics Design	20	2	*D_W03; D_U04; D_K05*
13.	Explosive effects on defensive structures	20	2	*D_W02; D_U01; D_K05*
14.	Scheduling and costing systems for construction works	20	2	*D_W06; D_U06; D_K08*
15.	Engineering of building materials	20	3	*D_W04, D_U04, D_K05*
16.	Cartographic methods of research	20	2	*D_W02, D_U05, D_U07, D_K03, D_K05*
17.	Spatial data exploration	20	2	*D_W02, D_W04, D_UWAT02, D_U01, D_U05, D_K03, D_K05*
18.	Data science in geospatial research	20	2	*D_W02,D_W03,D_UWAT02, D_U01, D_U05, D_K03, D_K04*
19.	Advanced methods of implementation of studies photogrammetric	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
20.	Programming in spatial information systems	20	2	*D_W02, D_W05, D_U06, D_U10, D_K03, D_K06*
21.	Reference systems in geosciences	20	3	*D_W02,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*
22.	Global Geodetic Observing System	20	3	*D_W01,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*
23.	Modern photogrammetric techniques	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
24.	Selected numerical methods in geodesy	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
25.	Methods of parallel data processing	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*
26.	Mathematical foundations of digital image processing	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
27.	Numerical methods with linear algebra	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
28.	Time series analysis in geodesy	20	3	*DW_03,DW_04,DW_05 D_UWAT02,D_U01,D_U02,D_U03,D_U04,D_U05,D_U07,D_U08,D_U010,D_U012,D_K03,D_K04,*

Annex V.4

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: materials engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Structural studies by X-ray diffraction	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*
2.	Structural studies by scanning microscopy	20	2	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*
3.	Mechanical Properties Testing of Engineering Plastics	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	20	2	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	20	2	*D_W01, D_W04, D_U05, D_K03*
6.	Semiconductor materials for optoelectronic applications	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*
7.	Nano and ultra-crystalline construction materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*
8.	Nanoporous anodic aluminum oxide: synthesis, Design & Applications	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U03, D_K01, D_K03, D_K05*
9.	Non-telecommunications applications of fiber optics	20	2	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*
10.	Measurements of machine and equipment parts with using coordinate measuring techniques	20	2	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*
11.	Experiment planning and data analysis with using Origin and Statistica	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*
12.	Basic properties of liquid crystals	20	2	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*
13.	Keysight Vee and Lab View in Control and data processing	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*
14.	Designing technological processes for incremental Direct Deposition methods	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
15.	Dielectric spectroscopy	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*
16.	Structural Determinants of Material Properties	20	2	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*
17.	Modern methods of material characterization	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*
18.	Contemporary information imaging systems and directions of their development	20	2	*D_W01, D_W06, D_U01, D_U02, D_U05, D_K03, D_K04*
19.	High-energy ball milling and mechanical synthesis	20	2	*D_W01, D_W01, D_U05, D_K03*
20.	Advanced materials for hydrogen storage	20	2	*D_W01, D_W03, D_U01, D_K04*
21.	Basics of plasmonics and metamaterials	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*
22.	Optoelectronic Imaging and Information Processing Techniques	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*
23.	Selected Materials and Functional Structures for Photonic Applications	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
24.	Computer Image Analysis in Materials Science	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*
25.	Additive manufacturing of functional materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*
26.	Methods for amplifying light emission from broadband semiconductor nanostructures	20	2	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U07, D_U10, D_K01, D_K03, D_K04, D_K09*
27.	Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals	20	2	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U10, D_K03, D_K04, D_K05, D_K09*
28.	Modeling of semiconductor devices.	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*
29.	High-entropy alloys – synthesis, structure, research and properties	20	2	*D_W01, D_W01, D_U05, D_K03*
30.	Additive manufacturing of phased alloys intermetallic	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
31.	Combinatorial Materials Manufacturing and Testing Engineering	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*
32.	Reactive mechanical grinding as a method for the synthesis of modern hydrogen storage materials in the solid phase.	20	2	*D_W01, D_W01, D_U05, D_K03*
33.	Additive techniques with elements of reverse engineering	20	2	*D_W02, D_W04, D_UWAT02, D_U03, D_U07, D_K03, D_K05*
34.	Overview of additive techniques used in modern technology	20	2	*D_W01, D_W03, D_UWAT02, D_D_U10, D_K03*
35.	Selected issues in 3D printing	20	2	*D_W01, D_UWAT02,D_U01, D_U08,D_K04, D_K05*

Annex V.5

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: mechanical engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	FEM Analysis in Load-Bearing Structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
2.	Autonomy of mobile robots	30	3	*D_U04, D_W03, D_K01*
3.	Non-destructive testing of aircraft	30	3	*D_W02; D_W05; D_U01; D_K05*
4.	Biomechanics of human body movement during a road accident	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
5.	Construction and operation of industrial robots	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*
6.	Digital signal processing	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*
7.	Design of experiment	30	3	*D_W04, D_U04, , D_K04,*
8.	Dynamics of mechatronic system design	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*
9.	Dynamics of car movement	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*
10.	Dynamics of hydrostatic systems	30	3	*D_U04, D_W04, D_K01*
11.	Dynamics of multi-member systems	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
12.	Solid collision dynamics	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
13.	Impulse loads of motor vehicles – selected issues	20	2	*D_W04, D_U04, D_K09*
14.	Computer-aided operation of machines	20	2	*D_W02, D_U05, D_K05*
15.	Shaping a safe car body	20	2	*D_W01, D_U04, D_K01, D_K05*
16.	Composite materials in mechanical engineering	30	3	*D_W01, D_W01, D_U04, D_K01, D_K05*
17.	Finite Element Method	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
18.	Methods of analysis of numerical experimental research results	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
19.	Methods of testing the condition of machines	30	3	*D_W03, D_U05, D_K01, D_K03*
20.	Experimental methods for investigating the thermophysical properties of solids	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*
21.	Methods and techniques for testing the mechanical properties of materials	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*
22.	Numerical Methods in Engineering Applications	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
23.	Numerical Methods in Mechanical Engineering	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
24.	Methods for designing and optimizing aircraft structures	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*
25.	Constitutive Models of Materials in FEM Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
26.	Modelling of heat transfer processes	30	3	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*
27.	Modeling hydraulic drive systems	30	3	*D_U04, D_W04, D_K01*
28.	Modeling and simulation of mechatronics issues	30	3	*D_W04, D_U04, D_K01*
29.	Modeling and simulation of nonlinear mechanical problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
30.	Parametric modeling and structural optimization with FEM	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
31.	Modeling Connections of Thin-walled Structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
32.	Flow modeling	30	3	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*
33.	Modeling machine motion	20	2	*D_U04, D_W04, D_K01*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
34.	Modeling composite structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
35.	Modeling of coupled problems (electrothermomechanical)	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
36.	Modeling of the Contact Phenomenon in Structural Mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
37.	Modeling and research of the processes of cooperation between the wheel and the road	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*
38.	Modeling of car traffic and controls	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*
39.	Modern technologies for bonding structural materials	30	3	*D_W01, D_W02, D_U05, D_K01, D_K05*
40.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	20	2	*D_U04, D_W03, D_K01*
41.	Renewable energy sources	30	3	*D_W06, D_U WAT02, D_K07*
42.	CAE Engineering Software	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
43.	Experiment planning and optimization of mechanical objects	30	3	*D_W04, D_U04, D_K05*
44.	Basics of road safety	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*
45.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*
46.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*
47.	Fundamentals of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
48.	Basics of modeling and simulation of nonlinear mechanical problems	20	2	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
49.	LabVIEW Basics	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
50.	Starting processes of internal combustion engines	30	3	*D_W04, D_U04, D_K01*
51.	Programming control systems for unmanned working machines and robots	30	3	*D_U04, D_W03, D_K01*
52.	Mechatronic sensors	30	3	*D_W03, D_W04, D_U06, D_K01, D_K04*
53.	Condition monitoring systems	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*
54.	Aircraft Operation Systems	30	3	*D_W03; D_U01; D_K03*
55.	Control systems in mechanical engineering	30	3	*D_U04, D_W03, D_K01*
56.	Technologies for the production and processing of composite materials	30	3	*D_W01, D_W02, D_U04, D_K01, D_K05*
57.	Development trends in automotive technology	20	2	*D_W01, D_W03, D_U04 D_K01, D_K05*
58.	Theory and organization of machine operation	30	3	*D_W04, D_U06, D_K03*
59.	Thermomechanics of materials and studies of thermophysical properties	30	3	*D_W03, D_W04, D_U01, D_K03*
60.	Tribology	30	3	*D_W03, D_U04, D_K05*
61.	Durability of aircraft structures	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*
62.	Introduction to the equations of mathematical physics	30	3	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*
63.	Modern machine and vehicle drive systems	30	3	*D_W03, D_U04, D_K05*
64.	Modern test methods for internal combustion engines and vehicles	30	3	*D_W04; D_U01; D_U02; D_U03; D_U04; D_U05; D_UWAT01;*
65.	Selected methods and techniques of temperature measurement	30	3	*D_W03, D_W04, D_U04, D_K05*
66.	Selected problems of rocket technology	30	3	*D_W03, D_U04, D_K05*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
67.	Selected issues of modern programming – introduction to modern programming languages	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
68.	Selected issues of waste gas treatment from motor vehicles	30	3	*D_W01; D_W02; D_W03; D_K03; D_K05; D_U010;*
69.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	30	3	*D_W01; D_W02; D_W03; D_U05; D_K01; D_K03; D_K05;*
70.	Fatigue strength and fracture mechanics of materials and structures	30	3	*D_W01, D_U04, D_K01*
71.	Advanced methods of manufacturing products from sintered powders	30	3	*D_W04, D_U04, D_K01*
72.	Advanced ballistics, modeling, and simulation	30	3	*D_W01, D_U04, D_K01*
73.	Advanced Mathematics	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
74.	Advanced modeling in structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*
75.	Advanced measurement systems	30	3	*D_W04, D_U04, D_K01*
76.	Advanced Materials Testing Methods	30	3	*D_W01, D_W02, D_W04, D_U02, D_U04, D_U05, D_K01, D_K05*
77.	Application of experimental mechanics in scientific research 1	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
78.	Application of experimental mechanics in scientific research 2	40	4	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*
79.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	30	3	*D_W01, D_W02, D_W03 D_U05, D_K01, D_K03, D_K05*

Annex V.6

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: chemical sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes
1.	Analysis of Chemical Warfare Agents	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*
2.	Chemistry and technology of liquid crystal materials	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*
3.	Chemistry and technology of high-energy materials	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*
4.	Electroanalysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
5.	Physics and chemistry of carbon materials	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*
6.	Physicochemical aspects of the explosion	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*
7.	History of chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
8.	Ionization methods in analytics	20	2	*D_W03, D_W04, D_UWAT02, D_K01*
9.	Methods for preparing samples for analysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
10.	Spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
11.	Latest trends in electrochemistry	20	2	*D_W01, D_W03, D_UWAT02, D_U03, D_K01*
12.	Modern nanoporous materials	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*
13.	Modern methods of synthesis of functional organic com-pounds	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*
14.	Signal Processing in Analytical Chemistry	20	2	*D_W03, D_W04, D_U05, D_K03*
15.	Synthesis of liquid crystals	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*
16.	Introduction to Spectroscopy	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
17.	Modern analytical chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
18.	Advanced pyrotechnics	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
19.	The use of gas chromatography in research Physicochemical	20	2	*D_W WAT01, D_W01, D_W02, D_U WAT01, D_U WAT02, D_K01, D_K03*
20.	Polymer chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*
21.	Modeling and simulation computer programs in chemistry	40	4	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*

Annex V.7

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: security sciences

L.p.	Item Name	Number of hours	Number of ECTS credits	Reference to learning outcomes
1.	Social research in security sciences	40	4	*D_W WAT01; D_W01; D_W06; D_UO3; D_K03;*
2.	Statistical methods in social research	40	4	*D_WO4; D_U O3; D_U04; D_KO1; D K03;*
3.	Security risk management	30	3	*D_WO1; D_W03; D_UO3;*
4.	Security Systems Project Management	30	3	*D_W03; D_U04; D_K05;*
5.	Safety Systems Engineering	30	3	*D_W03; D_W02; D_UO6; D_U10; D_KO5;*
6.	Safety propaedeutics	30	3	*D_W02; D W05; D_U01; D_K05;*
7.	Strategies and concepts of state security management	30	3	*D_W02; D_U04; D_KO5;*
8.	Crisis management in public administration	30	3	*D_WO1; D_W03; D_UO3; D_U12;*
9.	Universal safety	30	3	*D_W02; D_W03; D_U01; D_K07;*
10.	Internal security	30	3	*D_W02; D_W03; D_KO5; D_KO7;*
11.	Survey data analysis	20	2	*D_WO4; D_U04; D_KO1;*
12.	Multivariate analyses	20	2	*D_WO4; D_U04; D_U05; D_KO1; D_K03; D_K04;*
13.	Evaluation research procedures	20	2	*D_WO4; D_U04; D_U05; D_KO1; D K03*
14.	Logic and theory of argumentation	20	2	*D_WO4; D_U01; D_U04; D_U05; D_KO1; D_K03; D_K04;*
15.	Forecasting and simulations in security	20	2	*D_W03; D_W04; D_U WAT01; D_U05; D U13; D_K03; D K04; D K05;*
16.	Modern technologies in security	20	2	*D_WO1; D_WO2; D_U WATO1; D_UO6; D K03;*
17.	Philosophy of security sciences	20	2	*D_W02; D_W03; D_U01; D_U05; D_KO1; D_K03;*
18.	Modern terrorism	20	2	*D_W03; D_W06; D_U05; D_UO8; D_U09; D_KO1; D_KO6;*
19.	Morale and Security Culture in National and International Relations	20	2	*D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*
20.	Safety history	20	2	*D_W02; D_W03; D_U Wato2; D_U05; D_K03; D_KO9;*
21.	Strategic communication	20	2	*D_WO1; D_WO3; D_UO6; D_U10; D_KO1; D_KO5*
22.	Political security sector	20	2	*D_WO2; D_WO3; D_UO8D_U12; D_K02;*
23.	Shaping military security in the 21st century	20	2	*D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*
24.	Information security	20	2	*D_W06; D_U01; D_K05;*

L.p.	Item Name	Number of hours	Number of ECTS credits	Reference to learning outcomes
25.	The economic dimension of safety	20	2	*D_W03; D_U WAT02; D_U05; D_K03; D_K04; D_K05;*
26.	Energy security in the face of socio-economic transformation	20	2	*D_W04; D_U WAT01; D_U WAT02; D U05; D_U13; D_K03; D_K04; D_K05;*
27.	Social Determinants of the Security of Modern States	20	2	*D_W03; D_W06; D_U04; D_U05; D_KO5; D_K07;*
28.	Combating and preventing corruption	20	2	*D_WO1; D_W06; DU01; D U02; DU01; D U12; D_K07; D_K02;*
29.	Operational methods of combating serious criminal crime	20	2	*D_WO1; D_W03; DU01; D_U02; D_K07;*
30.	Environmental security on a global, regional and national scale	20	2	*D _W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D 1.113; D_K03; D_K04; D_K05;*
31.	Cultural security factors	20	2	*D_W03; D_W06; D_U04; D_U07; D_U10; D_K04; D_K05;*

Annex VI.1
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	Curriculum content
1.	Administering computer networks	IP networks. Routing in IP networks. Basics of Windows administration. Fundamentals of Linux system administration. Configuration of network devices. Services in LAN networks. Services in TCP/IP networks. Computer network diagnostics. Access networks. Network service servers. Computer network security.
2.	Data analysis experimental aided by computer-aided	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of univariate and multivariate data, processing of multidimensional experimental results using linear transformations, problems of discrimination including linear and non-linearly separable problems using simple methods of producing separating hyperplanes, methods of minimum distance classification, nearest neighborhood, k-means and hierarchical grouping.
3.	Smart Antennas	Basic properties of smart antennas. Construction of antenna arrays. Applied solutions for shaping the characteristics of smart antennas. An overview of algorithms used in smart antennas. The principle of operation of adaptive patterns, the properties of their components and the configurations in which they are used in practice. Simulation models of the adaptation process.
4.	Digital Computer vision	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
5.	Detectors Radiation Optical	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, photodiodes p-n, pin, APD, with Schottky barrier, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages.
6.	Electromechanical Energy converters and signals	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements.
7.	English for electronics	Mathematical symbols and operations. Notion of a function. Differential and integral calculus. Geometry Series and sequences. Vector, matrix and sets calculus. Probability and mathematical statistics. Uncertainties of measurements. Basic physical quantities and their units. Notion of a physical field Electric properties of media. Lasers and light properties. Theory of solids. Structure and constituents of an atom. Basics of quantum theory of an atom, wave function. Chemical elements and molecules' formation. Types of chemical bonding. Basic chemical nomenclature of chemical substances. Elements of materials engineering. General physicochemical characteristics of matter. Mechanical, electric, magnetic and optical properties of a substance Classes of materials. Thin films deposition technologies.
8.	Laser Physics	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
9.	Physics Laser Centers	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction. Energy levels of transition group metal ions. Phenomena of energy transfer be-

Lp.	Item Name	Curriculum content
		tween ions in active media.
10.	Photovoltaics	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.
11.	Functionalized nanomaterials Optoelectronic	Modern optoelectronic materials – introduction. The issue of functionalization in terms of increasing safety. Graphene - the production of properties. Carbon nanotubes – production and properties. Fullerenes – production and properties. Boron nitride production and properties. Methods of functioning of surface structures. Use core-shield systems. The role of nanomaterial geometry. Selection of composites for optoelectronic functioning. Spectroscopic methods for the study of optoelectronic nanostructures. Examples of functional solutions for special applications.
12.	Generation Radiation supercontinuum	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
13.	Engineering image information	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality – key system components, application solutions.
14.	Coding and recognition radio transmissions	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
15.	Crystallography	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
16.	Laser absorption spectroscopy in gas sensors	Gas detection methods and defining gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
17.	Laser-plasma X-ray sources and extreme ultraviolet (EUV)	Methods of producing X-rays and extreme ultraviolet radiation (EUV), basics of laser-generated plasma physics and X-ray and EUV optics, principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), examples of the use of these sources in science and modern technology.
18.	Lasers for medical applications	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser

Lp.	Item Name	Curriculum content
		systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications and the therapeutic and diagnostic effects obtained.
19.	Pico- and femtosecond	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
20.	Fiber lasers	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals - selected issues.
21.	Mathematical Field Models Electromagnetic	Mathematical differential relationships. Distribution. Orthogonal functions in electromagnetic applications. Wave propagation in materials and metamaterials. Analytical models for calculating the radiation field. Potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the far zone criterion for real antennas. Differential equations in electromagnetic problems. Computational electromagnetism - differential methods.
22.	Method finite elements	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
23.	Methods of analysis and measurement of random signals	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
24.	Methods and tools data mining	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
25.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations - condition index. Gaussian method of numerical solving of a system of linear equations. Direct methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Methods of numerical solving of ordinary differential equations.
26.	Methods of logical synthesis	Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
27.	Surveying and measurements	General conditions for carrying out measurements. Optoelectronic measurement sensors basic technical and metrological parameters. Measurement of the power

Lp.	Item Name	Curriculum content
	Optoelectronic	and energy of optical radiation. Testing of optical radiation power and energy meters. Laser distance and speed measurements. Measurement of wavelength and spectrum of optical radiation. Measurement of wavelength and spectrum of optical radiation. Measurements of polarization and coherence (degree of coherence) of laser radiation. Testing the resolving power of the monochromator, testing the spectrum of the selected laser. Lidars in research and their applications. Interferometric measurements. Optoelectronic measurement and recording systems.
28.	Modeling of physical phenomena and processes	Approximation (Linear Regression, Polynomial Mean Quadratic Approximation, Trigonometric Approximation, Fast Fourier Transform) Numerical Integration and Differentiation (Rectangular, Trapezoid, Simpson, Gaussian Quadrature). Ordinary differential equations (Euler's method, solution stability, Runge-Kutta method, systems of equations), laser modeling. Partial differential equations - Parabolic equations (Thermal conductivity – a simplified model of the interaction of laser radiation with matter), wave equation Numerical modeling of laser radiation diffraction in the paraxial approximation - a method of development into a number of eigenfunctions
29.	Nonlinear Radiation Conversion Laser	Elements of crystallography and crystal optics. Properties of uniaxial and diaxial crystals (KDP, LiJO3, LiNbO3, KTP, BBO, LBO etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector synchronizm. Generation 2□ and summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits.
30.	Scientific and engineering calculations	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
31.	Optoelectronics in systems Security	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.
32.	Laser optics	ABCD-2D and 4D methods in geometric and wave optics. Laser beam parameters and methods of their measurement. Gauss-Schell model of laser beam transformation in optical systems. Basics of coupling and shaping laser beams. Properties of the resonator and Fabry-Perot interferometer. Elements of the theory of resonators, mode structure of laser radiation. Thermo-optics components.
33.	Coherent Light Optics	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.
34.	Plasma in science and technology	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
35.	Remote Sensing Basics	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron paramagnetic resonance (EPR) (microwave spectroscopy). Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems. Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.

Lp.	Item Name	Curriculum content
36.	Designing safety systems	Security strategy and principles for creating technical protections. Normative principles and a set of good industry practices. The range of technical protection measures that can be applied. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor and outdoor applications. Working conditions and restrictions on this account. Structure of the technical and detailed design. The scope of the technical executive design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Rules for detailed design and cost estimation. Design study in the field of technical and detailed design. Required resources to lay the groundwork for the project. Threat analysis. The concept of technical protection of the security system. Rules for conducting a hazard analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. Attack scenarios and verification of the possibility of technical protection against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Methods of description and graphical representation of the technical design. The way documentation is organized. Examples of technical executive designs of critical infrastructure facilities. Documents related to the technical detailed design. Rules for the development of an investor's and "blind" cost estimate. The need to compile technical catalogues and technical data sheets of devices.
37.	ICs Programmable and specialized	Technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). Principles of digital circuit topography design, power distribution and clock distribution, I/O buffers, IP blocks, and design tools.
38.	Selected problems of digital signal processing	Discrete Fourier Transformation (DFT). Practical aspects of Fourier transformation. Wavelet transformation, mathematical basis. Mallat algorithm of decomposition and reconstruction of signals, 2-D wavelet transformation. Filtering of discrete signals, discrete filters, design of discrete filters, application of Matlab in filter design and analysis. Statistical signal processing. Statistical moments, correlation functions and their properties. Power spectral density. Estimation of spectra and moments. Higher order statistics.
39.	Acoustic sensors	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
40.	Microwave sensors in radar	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
41.	Smart radio networks	Smart radio network concept. CR architectures. Semantic context of CR. Problems of teaching in the CR system. Dynamic spectrum management. Problems of reception in CR. Ad-hoc CR networks, collaborative MIMO. Standards for CR networks. Security problems in CR. Current research programs in the area of CR.
42.	Optical spectroscopy in applications Biomedical	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński diagram Spectroscopic arrangement – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
43.	Digital Systems in the devices optoelectronic	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
44.	Test and measurement systems in the test laboratory	Signal conditioning systems. Control and measurement systems. Measurement signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
45.	Fiber optic technology	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.

Lp.	Item Name	Curriculum content
46.	Terahertz technique	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
47.	Concealment technique information (steganography)	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of hiding data – cases and scenarios of action.
48.	Thin film technologies	Historical outline of the importance of thin layers. The issue of the top layer. Thin film theory. Theory of thin film growth. Anti-reflective coatings and laser mirrors. Dichroic mirrors. Thin film polarizers. Radiation dividers. Interference and absorption filters. Solar cells. Methods of designing and manufacturing thin films. The role of nanocomposite geometry in increasing the optoelectronic functionality of surface structures. Methods of testing the properties of thin films. Quality control of surfaces and thin-film coatings – standards. Examples of functional solutions for special applications.
49.	Field theory	Basic concepts and equations of the theory of the electromagnetic field. Maxwell's equations, Properties of mediums and boundary conditions. Fields at the boundary of medium separation, Electromagnetic field energy. Types of electromagnetic phenomena, Electrostatics and magnetostatics. Stationary and quasistationary electromagnetic fields, Maxwell's equations in complex form for harmonic waveforms, Electromagnetic waves. Wave equation for the area without sources, Uniform plane wave. Propagation parameters of a homogeneous plane wave, Propagation of a homogeneous planar wave in a lossless dielectric, Propagation of a homogeneous planar wave in lossy dielectrics, Propagation of a homogeneous planar wave in a good conductor, Structure of a homogeneous planar wave, Reflection and refraction of a homogeneous planar wave at a planar boundary of two different mediums. Reflection and refraction of a homogeneous plane wave at the boundary of two different dielectrics, Reflection of a homogeneous plane wave propagating in a dielectric from the plane surface of a conductive medium Electromagnetic potentials and radiation, Potentials of alternating fields, delayed potentials. Hertz vector potential, Field of elementary oscillator, Electromagnetic field at short distances from the oscillator, Electromagnetic field at long distances from the elementary oscillator, Wave phase, wave type, phase velocity, Propagation of waves in parallel systems of conductors and in waveguides, Transverse electromagnetic wave TEM, Transverse magnetic wave TM in a rectangular waveguide, Transverse electric wave TE in a rectangular waveguide, Base Type, Cuboid Cavity Resonator
50.	Thermal imaging and infrared technology	Application of thermal radiation polarization in thermal imaging. Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Thermal imaging systems supporting the landing of aircraft. Modern infrared sensors with shaped and programmable detection zones. Active thermal imaging, measurement capabilities and prospects for its application. Multiband pyrometry for underwater oil exploration.
51.	Detection systems Radiation Optical	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
52.	Today's size transducers Physical	The concept of a measuring transducer and their classifications. Static and dynamic properties of transducers. Resistance strain gauges. Capacitive, piezoelectric, inductive, magnetoelastic, thermoelectric and pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic and acoustic transducers. Photoacoustic and photonic transducers. Integrated transducers.

Lp.	Item Name	Curriculum content
53.	Selected issues of the operation of anthropotechnical systems	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
54.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force. Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
55.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials. Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.
56.	Advanced technology microelectronics	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy structure of semiconductors.
57.	Laser applications in technology	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.
58.	Advanced techniques for digital system design in FPGAs	The Advanced FPGA Digital Systems Design Techniques course discusses issues related to, m.in others, the development of integrated digital systems in FPGAs, topographic design, effective use of design constraint attributes, preparation of functional tests, and good design practices. The course is divided into a theoretical part (lectures) and a practical part (laboratories and a project), and the results of the project work carried out are discussed at the seminar. Before taking the course, it is advisable to know the Hardware Description Languages (HDL) and the architecture of FPGAs.

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: technical informatics and telecommunications

Lp.	Item Name	Curriculum content
1.	Quantum Algorithms III	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	Algorithm Analysis III	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	Analysis and synthesis visual information III	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	Next-generation wireless systems	Development trends. Networking. Radio interface techniques. Development of services and applications. Organization and management in NG systems. Applications of artificial intelligence (AI) and machine learning (ML). Bulk systems, D2D (Device-to-Device) systems, transport systems. Cognitive NG networks. Green communication.
5.	ICT Systems Diagnostics III	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
6.	Efficiency of ICT systems III	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
7.	Elements Forecast Theory III	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.
8.	Software Evaluation III	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation.

Lp.	Item Name	Curriculum content
		Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
9.	Physical Fundamentals Quantum Information III	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
10.	Computer Graphics III	Introduction to computer graphics, basic applications - computer animation, visual simulation, AR and VR systems. Vector graphics, raster graphics - representation of image data. Basic graphics standards - GKS, PHIGS, OpenGL. Raster algorithms - Bresenham, anti-aliasing, HLHSR. Geometric modeling - curves and surfaces, 3D objects. Geometric transformations - translations, rotations, scaling, projection. Color modeling - color perception, CIE, RGB, HLS, HSV(B) color models, color space transformations. Lighting modeling - lighting models, shading algorithms, raytracing, radiosity. Texture Modeling - Defining, mapping, and filtering textures.
11.	Quality Engineering software III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
12.	Cryptology III	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
13.	Mathematical Methods of Decision Support III	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-making under uncertainty. Methods of determining the representation of sets of irreparable decisions. Methods for determining "approximate sets of optimal solu-

Lp.	Item Name	Curriculum content
		tions". Examples of modeling decision support processes.
14.	Discrete Mathematics III	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers. Break down the number into its components. Asymptotics. Creating functions. Asymptotic notations. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
15.	Generative methods and aspect in the manufacture of software III	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
16.	Numerical methods III	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
17.	Multi-Criteria Optimization Methods III	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
18.	Modeling Mathematics III	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin, maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of indistinguishability. Lower and upper approximation of the set. Approximation accuracy. Optimal decisions with approximate data knowledge. Decision boards. Deterministic and non-deterministic rules. Uncertain variables.
19.	Modelling	Basics of verification of ICT systems (ST) based on formal models: model verifi-

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	and network verification ICT III	cation, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-2, CPN Tools, UPPAAL.
20.	Modeling human-computer interaction III	Computer systems with a user – operator. User activity in the system and evaluation of the quality of operation. Modeling the user experience. GOMS modeling method. Keystroke-Level Model method. THERP method and other methods. A Markov model to assess the quality of user input. Semimarkian model for assessing the quality of user input. Analytical and simulation tools for quality modeling. Examples. Modeling the quality of user experience in systems with strong constraints. Problems with assessing the quality of user experience.
21.	Modeling Conflict Situations III	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
22.	Process modeling, simulation and analysis Business Enterprises III	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
23.	Reliability software III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and programmatic methods of shaping reliability software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability indicators, finite error models, infinite error models. Models in the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1-1988, IEEE/ANSI Std 982.2-1988.
24.	Reliability of Systems III	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for

Lp.	Item Name	Curriculum content
		non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for renewable facilities with zero renewal. Reliability of renewable facilities with non-zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of reliability structures. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
25.	Optimization III	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
26.	Probabilistic III	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.
27.	Stochastic Processes III	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
28.	Recognition and image processing III	Introduction to the issues of digital recognition and image processing. Basic problems related to digital image acquisition and how to solve them. Frequency methods in digital image processing. Basics of using transforms in digital image processing and analysis. Spatial methods in digital image processing. Improving the quality of images with the use of convolutional, ranking, logical filters - their advantages, disadvantages, ways of implementation. Introduction to digital image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Basic methods of image identification: classification in the space of features, structural method.
29.	Neural networks and fuzzy logic III	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
30.	Smart radio networks	Smart radio network concept. CRAHN ad-hoc networks. CR hardware and software architectures. Semantic context of CR. Problems of teaching in the CR system. Policies in the CR network. Dynamic spectrum management. Sensing and spectrum sharing. Collaboration and competition in CR networks. Security problems in CR. Standards for CR networks and CR solutions in NG (New Generations) networks
31.	Stochastic Exploitation Models III	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models

Lp.	Item Name	Curriculum content
		of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
32.	Computer Simulation III	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simulation systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
33.	Database Systems III	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
34.	Systems ICT III	Route and link availability control in the LAN environment: LAN link availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol: the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IP-Sec protocol, MPLS-based VPNs.
35.	Decision support systems III	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
36.	Artificial Intelligence III	Paradigms of artificial intelligence and areas of its applications, limitations of

Lp.	Item Name	Curriculum content
		artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search, simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
37.	Theoretical foundations of computer science III	Algorithmic theory of information. Accuracy and correctness of algorithms. Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transformations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
38.	Graph and Network Theory III	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. Complex graph as a special type of graphs. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms. Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
39.	Project management and Processes III	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of

Lp.	Item Name	Curriculum content
		projects and processes, planning the usability and functionality of project processes, planning the reliability of project activities, planning of control and verification of results, project risk management. Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the enterprise, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, management of communication in the project, methods and techniques of process improvement, models of process management development. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of the rhomboid model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
40.	Complex Data Structure III	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.
41.	5G network application for military	5G network technologies. 5G use cases and system concept. 5G Network Architecture. 5G architecture elements and functionalities/roles. Millimeter wave communications. Device-to-device (D2D) communications. The 5G radio-access technologies. Machine-type communications. Massive multiple-input multiple-output (MIMO) systems. 5G Network Miltary Gaps. Sensors and effectors. Military scenarios (use cases). 5G network Military Application and use cases:. 5G network in Spectrum Situation Awareness application (workshop). 5G network Military Application and use cases:. (own work/seminar/workshop with teacher support).

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering and transport

Lp.	Item Name	Curriculum content
1.	Safety and reliability of building structures	Knowledge in the field of safety and reliability of building structures. Classifications and rules for shaping the load-bearing structures of buildings and the conditions for assessing their safety. Methods of description and distribution of random variables. Functions of reliability and damage intensity. Methodology for conducting reliability tests, risk assessment, the safety of building maintenance and their effectiveness.
2.	Dynamic interaction of building structures with a soil medium	Methods of formulating computational models of the dynamics of structural elements and systems as well as the soil foundation medium of the building. Determination of the physical characteristics of the soil medium under static and dynamic loads. Influence of the content of the phases on the parameters of the substrate.
3.	Environmental physics	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits. Types of light sources for lighting. Indoor and outdoor illumination, luminous flux, illuminance, luminous efficacy, light source spectrum, standard observer, objective determination of the source color.
4.	Modeling of thermal and humidity processes	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
5.	Identification of loads and structural systems	Identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of the initiating reactions of the supporting systems of objects, which are revealed by static or dynamic displacements or vibration frequencies.
6.	Investment process in construction	Organization of construction investments, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
7.	Mechanics of road and airport runway soil foundations	Modeling of the soil as a single-phase or three-phase continuum depending on the type of soil (cohesive or no-cohesive). Stiffness and load carrying capacity of the ground as the problem of an elastic half-space. Dynamic effects generated by moving loads.
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
9.	Design methods of bridge structures Folding	Construction of folding bridges with determination of their technical and operational parameters. Theory of Calculation of Folding Bridges Taking into Account Mounting Clearances for Objects in Static and Dynamic Systems.

Lp.	Item Name	Curriculum content
10.	Design methods of the experiment	The essence of experimental research. Resistance extensometry. Measurements and analysis of measurement errors. Organization of the measurement line. Experimental methods of testing materials in simple stress conditions - tensile, compression, shear, bend, torsion tests. Materials testing in complex stress states. Assessment of rheological properties of materials - creep and relaxation. Optical research methods in mechanics – elastooptics, optical, mesh and holographic interferometry.
11.	Modeling the behavior of elements and structures reinforced concrete	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
12.	Nonlinearities geometric and physical in structural mechanics	Deformations of flaccid structures and bodies with low rigidity, the use of geometric relationships with linear and nonlinear terms. Consequences of deformation in equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.
13.	Impact explosives on defensive structures	Physics of phenomena generated by explosion of explosive charges and fuel-air mixtures. Methods of determining the parameters of explosion loads. Types of mechanisms destroying elements and load-bearing structures of buildings.
14.	Scheduling and costing systems for construction works	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
15.	Engineering of building materials	Contemporary trends in the modification of building, construction and finishing materials. Technologies of preparation, implementation and optimal procedures for incorporating materials and products under building conditions. Structure and material considerations of composites used in construction. The role of additives and admixtures in buildings technologies.
16.	Cartographic methods of research	The use of maps to describe, analyze and scientifically learn phenomena, including cartometric research, mathematical and statistical analysis and methods of mathematical theory of information. Issues related to, among others, distribution analyses (potential maps, concentration analyses), dynamics of phenomena, as well as correlation methods and trend methods.
17.	Data mining Spatial	Review of exploratory data analysis methods with particular emphasis on geospatial data, including classification and grouping, reduction of the number of variables, and spatial pattern discovery. Classification using decision trees and the Byesian classifier, hierarchical grouping, and quality evaluation of classifiers and model validation.
18.	Data science in geospatial research	Advanced geospatial data processing, analysis, and modeling. Searching for trends and dependencies using exploratory data analysis techniques, machine learning and artificial intelligence, m.in.: real estate market, land cover changes, population distribution. The quality of the data and its impact on the effect of forecasting and modeling, as well as effective reporting and visualization of results.
19.	Advanced methods of implementation of studies photogrammetric	Problems of filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF. Fundamental problems of contemporary digital photogrammetry. Digital image acquisition systems – photogrammetric digital cameras and VHRS and Nano satellite systems. Remote sensing and photogrammetric methods of data acquisition. Modern photogrammetric technologies – their applications in the development of site and elevation maps, digital terrain model and orthophotomaps, as well as 3D spatial maps. Application of Computational Intelligence Algorithms in contemporary photogrammetric studies. Characteristics of new multi-image fitting methods. Methodology for developing dense point clouds from images.
20.	Programming in spatial information systems	The use of the programming environment, the concept of procedure, function and instructions for data processing. A way of accessing and processing spatial data directly using programming code. Libraries that enable spatial data processing in the .NET environment, the ability to automate the ArcGIS environment using Python.
21.	Reference systems in geosciences	We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference. To be under-

Lp.	Item Name	Curriculum content
		stood in context, when the motion of the Earth's crust is observed, it must be referenced. The global geodetic frame of reference is the fundamental basis for measuring worldwide processes and is crucial for its proper interpretation especially for climatic studies. A terrestrial reference frame provides a set of coordinates of some points located on the Earth's surface. It can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space. This rotation is assessed with respect to a frame tied to stellar objects, called a celestial reference frame. The Earth Orientation Parameters (EOPs) connect these two frames together. Nowadays, four main geodetic techniques are used to compute accurate coordinates: the GPS (Global Positioning System), VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite). They all use networks of stations located on sites covering the whole Earth. Modern realizations are of kinematic type, which means that they include station positions and velocities. They model secular Earth's crust changes that is why they can be used to compare observations from different epochs. The Ph.D. students will learn about advancements of the International Terrestrial Reference System (ITRS) which is a World spatial reference system co-rotating with the Earth in its diurnal motion in space for the geodetic, but also astronomical, and geophysical communities.
22.	Global Geodetic Observing System	Global Geodetic Observing System (GGOS) is the Observing System of the International Association of Geodesy (IAG). GGOS and its related research and services address the relevant science issues related to geodesy, geodynamics and geophysics in the 21st century, but also issues relevant to society, like global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea level estimations and ocean forecasting, or the space weather. The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS mission is to: (i) provide the observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, (ii) provide the global geodetic frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications, and (iii) benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built. Within this subject Ph.D. students will advance their understanding of the dynamic Earth system by quantifying our planet's changes in space and time and learn about the integration within the geodetic, geodynamic and geophysical communities at the highest level, in service to the technical community and society as a whole.
23.	Modern photogrammetric techniques	A modern approach to photogrammetric studies based on the use of the latest techniques of processing imagery obtained from various altitudes and the use of their geometric relationships in the field of situational and elevation measurement in areas including: development and updating of maps, feeding topographic databases, supporting the construction of 3D cadastre, as well as cooperation with mobile systems in the field of building virtual reality at various levels of detail.
24.	Selected methods numerical in geodesy	Practical use of numerical methods to solve scientific and technical problems (geodesy), ideas and concepts of numerical methods, numerical algorithms, programming elements - computational scripts. Use of selected tool libraries of scripting languages such as Matlab, Octave and Scilab.
25.	Methods of parallel data processing	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods and functions of the Parallel Computing and MATLAB Distributed Computing Server Toolbox modules.
26.	Mathematical foundations of digital image processing	Creating gradient and edge filter masks based on differential diagrams constructed using the finite difference method (FDM) and the finite element method (FEM) (convergence, agreement, order of precision, π- as the first form of differential approximation). Spectral properties of masks (matrices of the third and fifth order), including the spectral transfer function and its graphical presentation. The goodness of the mask is defined as the quotient of the spectral transfer function of the filter under study and the visual transfer function of the differential transfer of the Laplace operator. Operations on masks (addition, subtraction, 45° rotation), determining the form of the differential operator related to the results of these

Lp.	Item Name	Curriculum content
		transformations (Laplacian, bi-Laplacian, etc.). Filters that identify only corners (vertices). Bi-Laplacian mask vs. Harris corner detector.
27.	Numerical methods with linear algebra	Vector norm, matrix norm, induced norm. Norm 1, 2 and maximum. Matrix conditioning indicator. The use of linear algebra methods in numerical (differential) solving of mathematical physics problems (advection equation, diffusion, diffusion problem with advection). Convergence and stability of the differential method. Spectral transfer operator. π- a form of the first differential approximation. Numerical diffusion, creation. Analysis of selected differential schemes in terms of spectral properties – explicit, implicit, semi-implicit scheme, Crakn-Nicholson, Crank-Nicholson-Galerkin. Dissipation and dispersion in Lax-Wendroff and Beam-Warming schemes used in civil engineering and trance-sport.
28.	Time series analysis in geodesy	This lecture is dedicated to doctoral students dealing with geodetic issues. In the case of geodetic observations, we mainly deal with the finite number of data as well as the occurring measurement errors. At the beginning, basic definitions regarding time series analyzes will be presented such as such as: stochastic process, signal, white and red noise, convolution, the Fourier and Hilbert transforms. Next the possibilities of analyzing time series and the relationships between them will be presented by introduction of the autocovariance and cross-covariance functions and their estimations as well as power spectrum, cross-spectrum, time lag and coherence. After introduction to digital filters including examples of Gauss, Ormsby, Butterworth and Fourier transform filter the following spectral analyzes methods will be presented: Blackman-Tuckey method, Maximum Entropy Spectral Analysis, Fourier Transform Band Pass Filter (FTPBF) Spectral Analysis. Next part of the lecture will be dedicated to prediction methods such as autoregressive and autocovariance forecasts. In the case of non-stationary time series in which the amplitudes and phases of oscillations change over time, time-frequency analyzes such as: Gabor transform, wavelet transform and Fourier transform band pass filter spectra-temporal analysis will be presented. In order to determine time-varying amplitudes and phases in time series the combination of the FTPBF with the Hilbert transform will be presented. To detect common signals in two time series the wavelet based semblance filtering method will be presented.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	Curriculum content
1.	Structural studies by diffraction methods X-ray	Basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	Structural studies by scanning microscopy	Terms used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Preparation used in reflection and transmission electron microscopy. Selected methods of advanced microscopic research (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of image and fractures).
3.	Mechanical Properties Testing of Engineering Plastics	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	Physical basis of electro-optical effects in Liquid Crystals (CK). Selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals.
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	Study of materials, in particular materials for storing hydrogen in the solid phase, using: differential calorimetry, thermogravimetry and volumetric analyses. Types of equipment, principles of operation, calibration methods, good practices of use, advantages, disadvantages, possibilities and limitations. Basics of analysis of test results, correction of results and selection of test parameters to obtain the best results.
6.	Semiconductor materials for optoelectronic applications	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic semiconductors).
7.	Nano and ultra-crystalline construction materials	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	Nanoporous anodic aluminum oxide: synthesis, design and applications	Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.). Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electrochemical synthesis (temperature, voltage, time). The process of self-organization of the matrix pores into a hexagonal system. Soft anodization. Hard anodization. Pulsed anodization. Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods). Applications of anodic aluminum oxide matrix (biosensors, filters, optoelectronic components, tissue engineering, etc.). New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	Non-telecommunications applications of fiber optics	Interference (phase) fiber optic sensor technology. Terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the definition of the role of the transducer as well as optical

Lp.	Item Name	Curriculum content
		and electronic signal processing. Methods of building sensors with a point and a distributed detection field. Multiplication of point sensors.
10.	Component measurements parts of machinery and equipment using coordinate measuring techniques	Use coordinate measuring techniques and tactile profilometry at various stages of the production process. Metrological properties of coordinate measuring machines and tactile profilometers Programming of a multi-sensor measuring machine to carry out measurements as part of the final acceptance of machine parts and equipment manufactured in mass production conditions.
11.	Experiment planning and data analysis using Origin and Statistica	The use of computer programs to plan an experiment. Statistical methods. Origin and Statistica's capabilities for experiment planning and data analysis.
12.	Basic properties of liquid crystals	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	Keysight Vee and Lab View for Data Control and Processing	Basics of programming in LabView, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops (for loop, while), selection structures, feedback, etc. How to use objects of various types (numeric, string, bool), including in the form of matrices and clusters. Methods of data processing and transfer. Creating a program algorithm to control a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Basics of programming in Keysight Vee, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops, selection structures, conditional statements, etc. A way of using objects of various types, including matrices and complex variables. Basic methods of data processing and transfer. Cooperation Keysight Vee – MS Excel. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	Designing technological processes for incremental Direct Deposition methods	Design of elements of machine and equipment parts using solid and surface modeling. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological process design - production of the target production series
15.	Dielectric spectroscopy	Dielectric spectroscopy (impedance spectroscopy/radio range spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics for the analysis of the properties of materials used in electronics. Electrical phenomena at the atomic, molecular, and macroscopic (medium) levels. Theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. Parasitic effects in impedance measurements. Research equipment (impedance analyzers), experiment and analysis of experimental data in the context of the properties of various materials.
16.	Structural Determinants of Material Properties	Terminology, methodology, critical reception of external data, critical evaluation of the results of solving scientific problems in the area of materials and technology. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions.
17.	Modern methods of material characterization	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.
18.	Contemporary information imaging systems and directions of their development	Modern imaging systems for direct observation: liquid crystal, organic LEDs, microleds, flexible and roll-up displays. Discussion of the effects and materials used. The level of solutions achieved, limitations resulting from the physics of effects, material possibilities, available technology. Projection systems used effects, solutions ranging from cinema systems through didactic systems to microprojectors. Directions of development of displays and projection systems.

Lp.	Item Name	Curriculum content
		Particular emphasis will be placed on combining knowledge about the physical effects used in the construction of displays, new materials (including nano- structures used in LCDs, OLEDs and microLEDs), and the possibilities of modern technology with compliance with environmental protection requirements.
19.	High-energy ball milling and mechanical synthesis	Issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. Types of ball mills, the principle of their operation, capabilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.
20.	Advanced materials for hydrogen storage	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity materials for hydrogen storage. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
21.	Basics of plasmonics and metamaterials	Basic definitions of plasmonics and metamaterials. Physical basics, interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces. Technological conditions for the implementation of metamaterial one-, two- and three-dimensional structures. Physical and technological requirements and limitations for different types of metamaterials, as well as the use of classical technologies for the production of nano- and metamaterials. Methods for simulation of the properties of selected metamaterial and plasmonic structures and methods for characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. Application of metamaterial structures in photonic devices and prospects for the development of nano- and metamaterials with particular emphasis on military applications.
22.	Optoelectronic Imaging and Information Processing Techniques	Colour vision, perception of black-and-white and colour information and the human-display-imaging interdependence, display requirements and ergonomics of various types of imagery. Physical and theoretical basis of the effects used in displays and their determinants. Active displays - fluorescent, plasma, electroluminescent, construction, characteristic parameters, purpose and passive displays - liquid crystal, electrophoretic, structure, parameters and conditions of applications. Segmented and multiplex liquid crystal displays as well as active matrix controlled liquid crystal displays. Projection systems, large-format displays, purpose, advantages, disadvantages. Organic and inorganic materials for displays and characteristics of their properties and elements of display manufacturing technology as well as characteristics of technological processes, methods of control and evaluation of display performance parameters. Methods of three-dimensional imagery, methods of implementation and application, teleimmersion.
23.	Selected Materials and Functional Structures for Applications Photonics	Properties and applications of such materials and structures as: optical glass and polymer substrates for the construction of electro-optical transducers, oxide and organic functional layers used as anti-reflective layers, bandstop and edge filters, transparent conductive organic and inorganic layers, nanomaterials for organic applications, photonic polymers and liquid crystals, including composite structures. Construction, construction and operation of selected photonic elements, made on the basis of, among others. the above-mentioned functional materials; spatial light modulator, dynamic wave plates, dynamic elements of diffraction optics (diffraction gratings), optical vortices, microlasers based on self-organizing structures, Kerr and Pockels cells, optical materials and elements for spatial imaging and others.
24.	Computer Image Analysis in Materials Science	Basics of stereology, including basic assumptions and stereological implementations. Detection methods and binarization procedures necessary for quantitative image analysis. Fundamentals of image acquisition and processing (m.in. morphological transformations, logical and arithmetic operations). Procedures carried out during computer image analysis in the study of real engineering materials.
25.	Additive manufacturing of functional materials	Practical aspects of additive manufacturing of functional metallic materials using LMD/LENS laser technology. Influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of functional materials.
26.	Methods for amplifying light emission from broadband semiconductor na-	Basic types of broadband semiconductors. Properties of luminescent broadband semiconductors on specific examples (e.g. GaN, ZnO, SnO2). Methods of synthesis of nanostructures. Modulation of optical properties of nanostructures at the

Lp.	Item Name	Curriculum content
	nostructures	synthesis stage. Post-synthetic methods of luminescence enhancement. Intentional doping of broadband semiconductors. The phenomenon of charge and energy transfer. The phenomenon of surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR). Plasmonic light gain from semiconductor nanostructures – basic criteria for coupling SPR or LSPR to the frequency of optical transitions in semiconductors at the metal/semiconductor interface.
27.	Electrochemical synthesis of anti-reflective, superhydrophobic coatings and photonic crystals	Basic knowledge of the production of porous anodic aluminum oxide (AAO). Parameters of electrochemical synthesis. The phenomenon of constructive and destructive interference. Single-layer and multi-layer interference. Features of an ideal anti-reflection coating. Anti-reflective coatings with graded refractive index. Microstructure of the moth eye. Surface wettability. High-energy vs. low-energy surfaces. Hysteresis of the contact angle. Wetting textured surfaces: Wenzel model vs. Cassie-Baxter model. General characteristics of 1D, 2D and 3D photonic crystals. Structural coloration. Inspirations drawn from nature, or what is biomimetics. Multi-stage electrochemical synthesis of AAO with conical pore shapes. Electrochemical production of 1D crystals by pulsed method. Design of voltage or current pulse sequences, taking into account processes limited by diffusion and the speed of ion transport through the barrier layer. Control of electrochemical synthesis parameters to obtain the desired photonic properties of AAO-based photonic crystals.
28.	Instrument modeling semiconductors.	The genesis of transport equations derived on the basis of the principles of behavior and postulates of thermodynamics of irreversible processes. Generation-recombination mechanisms responsible for the magnitude of charge carrier concentration. Contribution of cross-band processes and SHR mechanisms involving point defects, dislocations and surface states. Process modeling and determination of cross-sections. Mechanism of interband absorption of radiation. Construction of iterative diagrams enabling numerical solving of a system of transport equations. Record on the numeric grid. Problems related to numerical solving of nonlinear equations. He will be able to write a fragment of the program as a task to pass the subject. This fragment can be implemented into my program in order to design a specific device or to study the physical parameters of the structure.
29.	High-entropy alloys – synthesis, structure, Tests and properties	The latest group of materials – the so-called high-entropy alloys. Theoretical aspects of their formation and stability, properties, structure, synthesis methods and heat treatment. Practical attempts to synthesize and study the properties of alloys from this group.
30.	Additive manufacturing of alloys based on intermetallic phases	Specific aspects related to the additive manufacturing of alloys based on intermetallic phases (in particular FeAl). The influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of these materials.
31.	Combinatorial production and testing of engineering materials	Possibilities of using DED laser additive techniques for combinatorial search for new engineering materials. As part of the course, attempts will be made to synthesize both continuous and discrete alloy libraries and the possibility of their rapid study.
32.	Reactive mechanical milling as a method of synthesis of modern materials for hydrogen storage in the solid phase.	Synthesis of solid-phase hydrogen storage materials using reactive hydrogen grinding in ball mills. Attempts at the synthesis of selected metal hydrides and complex hydrides and studies of the influence of synthesis conditions on its result and the properties of the produced material.
33.	Additive techniques with elements of reverse engineering	Devices used in reverse engineering. Editing and processing of point clouds and generation of STL files, taking into account technological specifics. Preparation for 3D printing (model positioning, material selection, degree of infill, division into layers, source code generation). Multi-variant production of models with complex geometry using FDM and SLA techniques. "Post-processing" and assessment of the quality of the obtained printouts using a 3D scanner and a micro-computed tomography.
34.	Overview of additive techniques used in modern technology	The idea, technical solutions and development trends of 3D printing. Overview of additive methods used in strategic industries – material, technological and economic conditions. Specifics of the processing of high-strength thermoplastics used in aviation and medicine – devices, technological parameters of 3D printing. Evaluation of the geometric and metallurgical quality of sample parts of printed machines using various additive techniques. Additive technologies and Industry 4.0.
35.	Selected issues in 3D printing	Analysis of the possibility of manufacturing structural elements using Rapid Manufacturing techniques. Specificity of processing advanced construction materials

Lp.	Item Name	Curriculum content
		using laser additive forming methods. Material tests and assessment of geometric quality of printouts. Traditional vs. laser methods of regeneration of machine and equipment parts. Analysis of the possibility of reconstructing the operating indicators of machine and equipment parts using the semi-industrial LENS system – multi-criteria quality assessment.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

Lp.	Item Name	Curriculum content
1.	FEM Analysis in Load-Bearing Structures	Theoretical foundations of numerical methods of analysis with the use of rigid bodies and the strategy of computer simulation of multibodies with the use of various algorithms for the formulation of equations of motion and their integration. Overview of multibody analysis software environments and examples of mechanical engineering solutions. Methods of modeling mechanical structures with rigid solids in planar and spatial systems. Construction of planar and spatial models with the use of various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected issues of mechanical engineering. Multivariant numerical analyses with attention to the selection of optimal calculation parameters and the assessment of the correctness of the obtained results using analytical and experimental methods.
2.	Autonomy of mobile robots	Basic terms and definitions of mobile robots. Basics of wheeled robot control. Navigation with markers in the robot's environment. Issues of navigation, self-localization, odometry in connection with the construction of the robot. Determining the position of the robot based on the map. Vision systems in mobile robotics.
3.	Non-destructive testing of aircraft	Types of defects, defects and damage that threaten the safety of operation of technical facilities. Non-destructive testing methods – physical basis. Visual and penetrative methods. Ultrasound method. Acoustic methods. Eddy current method. Thermographic method. X-ray method. Shearograps and DSight. Non-destructive testing methods – advantages, disadvantages and limitations in use. Non-destructive testing certification.
4.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of the human body model and experimental research.
5.	Construction and operation of industrial robots	Construction and operation principle of industrial robots. Principles of robotization of production lines. Environments and languages for programming industrial robots
6.	Digital signal processing	Mathematical models of deterministic signals in digital circuits. Time-frequency analyses of digital signals as well as algorithms and methods of their processing. Hardware implementation of selected algorithms in DSP signal processors.
7.	Design of experiment	Determined and randomized experiment plans. Measures of position and dispersion of measurement results. Assessment of the significance of the impact of input quantities on the output quantity. Specify a function that approximates the function of an object. Assessment of the adequacy of the function of the facility and the significance of its coefficients. Experiential optimization.
8.	Dynamics of mechatronic system design	Issues of modeling mechatronic systems. Elements of motion and vibration analysis of linear systems with single and multiple degrees of freedom. Elements of motion analysis of nonlinear mechatronic systems. Stability testing of linear and nonlinear mechatronic systems. Self-excited vibrations. Methods of measuring vibrations of mechatronic systems.
9.	Dynamics of car movement	Modeling the movement of the car. Analysis of the dynamics of rectilinear and curvilinear motion. Modeling the process of a car crashing into an obstacle. Analysis of car vibrations.
10.	Dynamics of hydrostatic systems	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis and its description.
11.	Dynamics of multi-member systems	Theoretical foundations of numerical methods of analysis of load-bearing structures in the linear range (including multi-stage analyses), strategy of computer simulation of FEM of two- and three-dimensional problems in the field of mechanics and strength of materials and methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphics preprocessors (mainly MSC. Patran). Construction of 2D and 3D models for analysis in the field of selected engineering issues, performance of calculations with attention to the selection of optimal analysis parameters and evaluation of the correctness of calculation results using analytical methods and

Lp.	Item Name	Curriculum content
		available results of experimental research, on the example of elements and subassemblies of load-bearing structures.
12.	Solid collision dynamics	Equations of the dynamics of solid collision. Collision energy balance. Deformation and restitution. Modeling of post-collision motion of solids that are subject to deformation in the area of their contact. Biomechanical models for the analysis of shock loads.
13.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
14.	Computer support for the operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
15.	Shaping safe car body	Body construction – shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
16.	Composite materials in the construction and operation of machines	Definition and classification of composite materials. Strength and performance properties of composite materials. Technologies for the production of composite materials. Research used in the experimental analysis of mechanical properties of composites. Joining composite materials. Metal-composite joints. Exploitation of composite materials. Repairs of composite structures.
17.	Element Method Finite	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
18.	Methods of analysis of the results of numerical and Experimental	Selected deterministic and stochastic examples in the research methodology allowing the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
19.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
20.	Experimental methods for testing properties thermophysical Solids	Thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
21.	Methods and techniques for property testing Mechanical Materials	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring deformations during strength tests. Methods of testing the mechanical properties of materials under shock loading conditions.
22.	Numerical methods in applications Engineering	Concepts and basic methods of numerical calculations. Selection of appropriate methods of numerical analysis. Design and construction of computational algorithm programming.
23.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
24.	Design methods and optimization of aviation structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission mo-

Lp.	Item Name	Curriculum content
		deling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
25.	Constitutive Models of Materials in FEM Analysis	Mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. Experimental studies to determine the parameters of models. Numerical analyses using learned material models.
26.	Modeling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software
27.	Modelling hydraulic drive systems	Modeling of hydrostatic drive assemblies, subassemblies, elements and systems. Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
28.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
29.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
30.	Modelling parametric and design optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
31.	Modeling Connections of Thin-walled Structures	Overview of thin-walled structures. Materials used in thin-walled structures. Types of connections. Principles for designing selected types of connections, e.g. glue, rivet, screw. Introducing concentrated load into the structure. Modeling thin-walled structures including joints. Analysis of the strength of the selected connection of thin-walled structure elements.
32.	Flow modeling	Methods of computer modeling of flow processes in basic and applied problems of fluid motion dynamics. Simulation methods for researching streamlined issues. Basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver. Modeling of flow turbulence, including averaged Navier-Stokes equations, turbulent stress tensor, turbulence modeling capabilities and problems. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES). Mapping of complex simulation study objects, construction and execution of basic operations on computational grids, analysis of the reliability and accuracy of numerical modeling results.
33.	Motion modeling Machines	General principles of modeling mechanical, hydrostatic, electromechanical systems. Deterministic and random processes. Dynamics of systems with variable mass.
34.	Modeling composite structures	The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.
35.	Modelling conjugate issues (electro-thermomechanical)	Equations of the mathematical-physical model describing coupled phenomena, as well as initial-boundary conditions taking into account the influence of various factors and phenomena (thermal, electrical, mechanical). The use of simplifications enabling its solution with the use of numerical methods. Analysis of thermo-electrical and electrothermomechanical phenomena
36.	Modeling of the Contact	General division of contact phenomena. Mathematical foundations of the de-

Lp.	Item Name	Curriculum content
	Phenomenon in Structural Mechanics	scription and solution of the problem of contact. Algorithms for defining and solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
37.	Modeling and research of the processes of cooperation between the wheel and the road	Issues of modeling and testing the processes of cooperation between the wheel and the road to the extent necessary to model the dynamics of vehicle motion (selected mathematical models, methods and techniques of testing tire wheels on a drum stand and with the use of a test trailer).
38.	Modeling of car traffic and controls	Review of vehicle motion dynamics models and models describing the driver-vehicle-road system (models of lateral dynamics of the car in various control configurations).
39.	Modern technologies for bonding structural materials	Friction stir welding (FSW), laser beam welding (LBW), areas of application and strength properties of the cohesive joints obtained. Influence of bonding processes on the microstructure of selected construction materials. Heat treatment of FSW and LBW cohesive joints.
40.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
41.	Renewable energy sources	The importance of energy in the development of modern civilization. Modern fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
42.	CAE Engineering Software	An overview of CAE engineering support systems with an indication of their purpose and the possibility of using them in structural analyses. Preparation of numerical models for calculations in the static and dynamic range. Running calculations and presenting and processing the results obtained.
43.	Experiment planning and optimization of mechanical objects	Optimize your experiment using experiment plans and statistical models. Factor plans. Optimization plans. Determined plans. Plans to be analyzed, composition – property. Analysis of the relevance and adequacy of statistical models. Methods of determining the extremum of statistical functions. Examples of the use of experiment optimization in mechanical engineering.
44.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Statistics of road accidents and their interpretation.
45.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
46.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.
47.	Fundamentals of Mechanics of Continuous Media	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.
48.	Basics of modeling and simulation of nonlinear mechanical problems	Numerical methods in the aspect of nonlinear analysis of complex problems in the field of statics. Numerical methods to describe the issue of interactions between bodies. FEM in complex problems of dynamic analysis of a system of bodies.
49.	LabVIEW Basics	Hardware and software from NI. The process of creating an application in LABVIEW. Data Types in LABVIEW, Complex Data Types in LABVIEW, Communication with Measurement Devices in LABVIEW.
50.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.

Lp.	Item Name	Curriculum content
51.	Programming control systems for unmanned working machines and robots	Introduction to the UML standard. Build relational schemas and use case schemas. Creation of control algorithms. Introduction to programming, programming devices for hydrotronic applications. Design a feedback loop. Implementation of feedback loops in control systems.
52.	Mechatronic sensors	Mathematical models of mechatronic sensors. General principles of mechatronic sensors. Methods of measurement, errors and methods of calibration of sensors.
53.	Condition monitoring systems	Sensors used in condition monitoring. Resistance strain gauge. Fiber optic sensors. Crack sensors. Data transmission. Recording and analysis of measurement data. Inference. Coupling of condition monitoring systems with the operating system and the operation system.
54.	Aircraft Operation Systems	Principles of operation and repair of military aircraft in the Republic of Poland. Harmonized European Military Airworthiness Regulations (EMAR). European Airworthiness Regulations (PART). The role of EASA and the Civil Aviation Authority in supervising the operation of aircraft. Bulletins and other documents regulating the operation.
55.	Control systems in mechanical engineering	Logic fuzzy. Hardware configuration of PLCs. Simple tasks of logic control IEC 61131-3 standard – programming languages. Synthesis of the process and control algorithm of the SFC method. GPS control systems
56.	Technologies for the production and processing of composite materials	Composites, ways of defining them, types of components that make them up, the most important methods of their production and processing, the importance of this class of materials in mechanical engineering. The structure of modern composite materials depending on the method of production and the treatment used, e.g. heat, thermo-plastic. Manufacture of ceramic matrix composites and multilayer metallic composites and achievements in the use of composites.
57.	Development trends in automotive technology	Problems of the development of automotive technology and road traffic. Concepts of intelligent transport systems. Development tendencies in the construction of drive and chassis systems. Discussion of selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs). Car occupant safety system and driver assistance systems. Development of vehicle lighting systems. Hybrid, electric, autonomous cars.
58.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
59.	Thermomechanics of materials and studies of thermophysical properties	Phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and presentation of selected issues of statistical description of these phenomena to explain the nature of thermo-physical properties. The phenomenon of heat transfer in materials and material structures. Methodology of thermophysical research. Thermal Analysis Methods.
60.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.
61.	Durability of aircraft structures	Methods for determining and testing aircraft durability. Concepts of aircraft operation, factors limiting the durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in aircraft operation. Corrosion of aircraft.
62.	Introduction to the equations of mathematical physics	Formulation of mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. General principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics. The method of reducing borderline issues

Lp.	Item Name	Curriculum content
		to a dimensionless form is discussed. Formulation of mathematical models based on mathematical physics equations.
63.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
64.	Modern test methods for internal combustion engines and vehicles	Identification of the purpose of research. Selection of the test method. Validation of research methods and procedures. Approval test procedure. Selected methods of homologation tests, measuring equipment. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty Analysis and presentation of research results. Calibration of measurement systems. Practical implementation of selected research methods.
65.	Selected methods and techniques of temperature measurement	Theoretical basics of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. Types of thermometers: liquid, thermoelectric, resistive, thermistor, quartz, bimetallic, radiation, fiber optic and thermal imaging cameras. Statistical processing of measurement results
66.	Selected problems of rocket technology	Mathematical models of physical processes related to the dynamics of rocket motion. General rules for building rockets. Construction of rocket compartments with mathematical models. Computer simulation and visualization of the rocket flight path. Overloading of rockets on the flight path.
67.	Selected issues of modern programming – introduction to modern programming languages	Introduction to the object-oriented programming paradigm. Intermediate code and runtime issues. Introduction to C# and Microsoft Visual Studio. Create console programs using C# and Microsoft Visual Studio. Introduction to Python. Creating programs based on selected algorithms.
68.	Selected issues of waste gas treatment from motor vehicles	The impact of the automotive industry is influenced by the natural environment. Characterization of harmful substances. Systems and methods of motor vehicle waste gas treatment. Development tendencies in flue gas cleaning methods. Test methods and equipment for testing waste gases from internal combustion engines and vehicles. Studies on the influence of the operating condition of an internal combustion engine on the emissions of individual exhaust components and the granulometric composition of particulate matter.
69.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	Simulation tasks. Selection of the simulation method. Selected models of the work cycle of an internal combustion engine. Workflow simulation software. Procedure for simulating selected routings. Analysis and presentation of simulation results. Evaluation of simulation results. Simulation of selected working processes of internal combustion engines.
70.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Application of the principles of fatigue strength of materials and fracture mechanics in the operation of structures. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Fatigue test methodologies and fatigue testing equipment.
71.	Advanced methods of manufacturing products from sintered powders	Manufacturing processes of machine parts using modern methods of manufacturing engineering, including powder metallurgy.
72.	Advanced ballistics, modeling, and simulation	Methods of analysis, research and modeling of advanced ballistics phenomena. The use of modeling methods to analyze selected phenomena of internal, external or final ballistics.
73.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
74.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
75.	Advanced measurement	Structure and organization of computer-controlled measurement systems and

Lp.	Item Name	Curriculum content
	systems	with procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. Programming basics and how to use virtual instruments to collect, collect and process measurement data.
76.	Advanced Materials Testing Methods	Methods of testing materials, possibilities and limitations of various test methods based on the use of specialized equipment. Modern electron microscopy, confocal microscopy and X-ray microanalysis (qualitative and quantitative) and their practical application in mechanical engineering. Methods for investigating the macro- and microstructure of metals, their alloys and ceramic materials, and interpreting the test results obtained by various materials testing methods. Topographic contrast and its use for fractography studies, evaluation of changes in the microstructure of materials as a result of treatments, studies of powders and thin surface films. Microanalysis of phases and inclusions in materials research. Testing of material heterogeneity. Trace analysis of elements. Light microscopy in materials research. Metallography. Image analysis. Electron beam and its properties. Electron diffraction. Structure of a scanning and transmission electron microscope.
77.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
78.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
79.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	Issues related to wave propagation (elastic, plastic). Mathematical description of the phenomenon of mechanical wave propagation. Boundary conditions. Methods to solve the presented issue. Numerical analysis of wave propagation.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

Lp.	Item Name	Curriculum content
1.	Combat Analysis poisonous agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and Materials Technology Liquid crystal	Molecular structure, structures and textures of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and Materials Technology high-energy	Current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels: structural determinants of the stability and sensitivity of explosive compounds; design, fabrication and characterization of nanostructured explosive mixtures; principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; New ways to craft explosive compositions and form them into charges. design, manufacture and characterization of thermobaric explosives; design, synthesis and explosive properties of complex compounds; design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids as well as new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Electroanalysis	Basics and classification of electrochemical methods of analysis. Potentometry. Electrogravimetry. Coulometry. Polarography. Volammetry. Conductometry. Amperometric titration. Capillary electromigration techniques - apparatus for capillary electrophoresis and the principle of separation of mixture components. Capillary isotachophoresis (CITP). Micellar Electrokinetic Chromatography (MEKC). Capillary gel electrophoresis (CGE). Capillary Isoelectric Focusing (CIEF). Capillary electrochromatography (CEC). Overview of the application of electrochemical methods in practice.
5.	Physics and chemistry carbon materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and bioactivity of carbon materials. Prospects for the development of new carbon structures and their applications.
6.	Physicochemical Aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
7.	History of chemistry	Synthesis of elements in the universe, first observations and chemical achievements of antiquity (alchemy). History of chemical discoveries in the world: physical chemistry, analytical, chemical analysis, organic synthesis, food chemistry.

Lp.	Item Name	Curriculum content
		Achievements of chemistry after 1661 (R. Boyl). Development of separation techniques and analysis and their impact on the development of views on chemistry and the structure of chemical compounds. Evolution of nomenclature and symbols of elements and chemical compounds. History of the periodic table, kinetic and thermodynamic studies. The development of chemistry and organic synthesis in the twentieth century and its impact on the emergence of molecular biology.
8.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
9.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
10.	Spectroscopic methods	Expanding the knowledge on spectroscopic methods for PhD students in the discipline of chemical sciences. Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Modern spectroscopic methods.
11.	Latest trends in electrochemistry	Modern models of the double electrical layer (EDL). Voltammetric techniques. Currently used materials and designs of working electrodes. Electrochemical Impedance Spectroscopy (EIS) and its applications. New fuel cell designs, biofuel cells, coal-powered cells, construction. New electrocatalytic circuits, applications. The latest types of lithium-ion batteries. Lithium-sulfur batteries. Application of intercalation in electrochemistry. Electrochemical capacitors (EDLC), construction. Ionic liquids (ILs). Application of carbon materials in electrochemistry. Electrochemical methods for surface modification of solids. Electropolymerization. Conductive polymers.
12.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Adsorption of nitrogen and argon as a complete method for determining the specific surface area, porosity and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and investigation of adsorption properties of graphene composite materials. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
13.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials
14.	Signal Processing in analytical chemistry	Basic methods of processing the analytical signal. Spectra obtained from measuring instruments used in analytics. Big data processing. Multivariate data obtained from combined measurement techniques. Search for analytical information contained in large data sets. Elements of chemometrics. Principal components method. Similarity analysis. Presentation of measurement data in scientific publications.
15.	Synthesis of liquid	Introduction to liquid crystals, structure and anisotropic properties. Applications of

Lp.	Item Name	Curriculum content
	Crystals	liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Super fluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
16.	Introduction for spectroscopy	Basic knowledge of spectroscopic methods for PhDs in disciplines other than chemical sciences. Two versions of the item are possible. Standard version: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Individual version in accordance with the interests of the PhD student, extending selected spectroscopic methods from the given group of methods: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). Oscillation-rotational and rotational spectroscopy. One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Circular dichroism spectroscopy (ECD and VCD). Mass spectrometry (MS).
17.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
18.	Advanced pyrotechnics	The latest solutions used in military and civilian pyrotechnics. Currently used reducers, oxidants, binders and modifiers. Pyrotechnic applications of high-nitrogen compounds. Modern compositions of curtain smokes active in the infrared range. Modern multi-base solid rocket fuels. Solutions used in airbag inflators. Prospective applications of pyrotechnic mixtures in medicine. Basic algorithms used in modeling combustion processes and analytical optimization of the composition of pyrotechnic compositions.
19.	Use gas chromatography in research Physicochemical	The essence of interactions in chromatography. Mechanisms of chromatographing test substances. Basic chromatographic quantities. State functions – methods of calculation and interpretation. Study of the physical transformations of pure substances. Phase stability and phase transitions. Study of surface properties and basic surface phenomena. Methods of surface determination and analysis.
20.	Polymer chemistry	Polymers obtained in the process of polychain reaction. Condensation polymers, polyadducts. Inorganic-organic polymers. Polymers of natural origin. Special-purpose polymers.
21.	Modelling and simulation computer programs in chemistry	Fundamentals of Computational Chemistry: Computational Assumptions and Methods. CHEMCAD program organization and basics of use. Application of CHEMCAD in chemical technology and materials engineering. Implementation of a project in the field of chemical technology using the CHEMCAD system. Organization of the SCIGRESS program and basics of use. Optimization of geometry and calculation of physicochemical properties of molecules. Modeling of chemical reactions in the gas phase and solution. Modeling of spectroscopic properties of molecules.

Annex VI.7
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security sciences

No.	Item Name	Curriculum content
1.	Social research in the sciences Safety	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Non-reactive methods. Desk *research*
2.	Statistical methods in research Social	Population and sample. Statistical features. Measurement scales. Random variables. Normal distribution. Characteristics of qualitative and quantitative characteristics. Nonparametric estimation. Parametric estimation (point and interval). Verification of statistical hypotheses. Diagram of the materiality test. Testing the normality of the distribution. Problems of analysis of the interdependence of phenomena. The research process in the social sciences and the typical structure of scientific work. The course of data collection, analysis and evaluation.
3.	Risk management in security	Risk concept and risk management process. The concept of risk and risk management. Development of the risk management field. Risk management process. Risk measures. Types of risk in the security sector. Risk measurement in public sector entities. Risk measurement in the context of ensuring system continuity.
4.	Management system designs Security	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
5.	Safety Systems Engineering	The place of systems security theory in the family of sciences. Basic concepts of system security (system status, description of system security-related states, system security indicators). Principles of mathematical modeling of system security. Component and subsystem safety. Systems security models. Systems security research. Analysis of system security. Control of safety, systems.
6.	Propedeutyka Security	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies are the "old" and "new" wars in the interpretations of realism and constructivism.
7.	Management strategies and concepts Security state	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal functional factors and ways of defining security in doctrines and strategies (comparative analysis).
8.	Management Crisis in administration Public	Contemporary concepts of crisis management (the concept of vulnerability, the concept of resilience, the concept of adaptation). The subject of crisis management. Legal basis of crisis management in Poland. Crisis management process. Basic types of threats – sources of crisis situations. A crisis situation. Crisis management system in Poland. Effectiveness in crisis management.
9.	Safety Common	The essence of public safety. General security and national security. Mechanisms shaping public safety. Rescue. Civil protection. Civil Defense. Fire protection. Critical infrastructure protection. Organization of the protection of human life and health, material and cultural goods and the natural environment Methods and tools used to ensure public security in Poland and the EU.
10.	Safety Internal	Perception of security. Political determinants of internal security. Institutional system of internal security. Administrative police in the internal security system. Private entities in the organization of internal security. Organization of security in the region. Organization of security in the district. Organization of security in the district.
11.	Data analysis Survey	Creating measurement tools. Sampling. Preliminary analysis. Schedule analysis. Contingency tables, boundary and conditional distributions. Analysis of single-choice and multiple-choice questions. Significance and strength of the relationship between nominal and ordinal variables. Hypothesis testing.

No.	Item Name	Curriculum content
12.	Analysis Multidimensional	Methods of graphical presentation of multidimensional data. Multiple regression analysis. Analysis of canonical correlations. Principal components analysis. Exploratory Factor Analysis (EFA). Multidimensional scaling. Linear ordering. Cluster analysis.
13.	Test procedures Evaluation	The concept of evaluation research. History and institutionalization of evaluation research. Types of evaluation research – the concepts of "impact assessment", "action research". Differentiation of evaluation research in terms of their social functions. Experimental designs in evaluation studies. The Concept of Experimental Society by A. Etioni. Monitoring and evaluation. Elements of cost-benefit analysis in evaluation research. Measurement problems in evaluation research.
14.	The theory is logical Argument	Logical argumentation. Deductive, reductive and inductive inferences. Diagrams and argumentation diagrams. Recognizing arguments. Diagram. Classified premises and conclusions. Elements of the evaluation of argumentation. Acceptability of premises. Reliability of sources. Relevance.
15.	Forecasting and simulations in security	Forecasting and social practice. Social premises for predicting behavior. Forecast vs. decision-making. Model methods. Extrapolation of trends. Validity, admissibility and error of the forecast. Forecasting based on time series. Forecasting based on econometric models. Heuristic forecasting models. Social simulations.
16.	Modern technology in security	Know-how, modern technologies and their importance in ensuring safety. Modern technologies in the defense and protection system. Modern technologies in the economic security system of the state. Modern technologies in the social security system. The use of modern safety technologies in electricity generation, in the transport system, in the protection of critical infrastructure, in the protection of the natural environment.
17.	Philosophy of Sciences Safety	Origins, subject and branches of philosophy and philosophy of security as the most general knowledge about security. The genesis and types of human knowledge in philosophical discourse (sources: mystical, intuitive, philosophical and scientific; types: scientific, theoretical, practical and intuitive). The logic of scientific discovery, revolution in science and the progress of knowledge in the view of contemporary epistemology. Semantic analytics of the name security and types of its understanding – the essence of security in philosophical terms. A natural and conventional concept of security. Materialistic, idealistic and realistic concepts in the hermeneutic anchoring of security. The Praxeological Concept of the Four Simple Acts and Universal Methods of Shaping Security. Tendencies in Broadening, Deepening and Thickening Security Studies The Method of War, Peace, Non-Peace and Non-War in Praxeological Approach. Philosophical problems of security in contemporary societies of control and surveillance from the perspective of dataism and technohumanism.
18.	Modern terrorism	Basic concepts and their meaning. The origins of terrorism. Causes of modern terrorism. The main factors generating and escalating terrorism. Systematization of the causes of terrorism. A triad of terrorist motivation. Key elements and types of terrorist threat. The scope and nature of terrorism at the beginning of the 21st century. Effects of terrorism. Preventing and combating terrorism.
19.	Morals and culture Security in relationships National and international	The essence and importance of the security culture (KB) and morale (M) of physical and legal entities in internal and international relations. Psychosocial and praxeological models and "mechanisms" of KB and M functioning – relations between them. Safety culture (KB) and morale as types of key resources and competitive advantage factors in "normal" and crisis situations. Security culture as an interface integrating the security areas in question and the national security system (SBN). Intuitive and scientific ways of diagnosing and improving KB and M. Security culture and morale in times of information warfare and asymmetric conflicts
20.	History Security	Military, political and economic security of medieval Polish and the Polish-Lithuanian Commonwealth until its collapse. The main problems of European security in the nineteenth century. Polish national uprisings of the nineteenth century. World War I. Determinants of international security in the interwar period. Military, political, economic and social security of the Republic of Poland (1918–1939). World War II. International security in the second half of the twentieth century. U.S.-USSR relations and their impact on international security. Military, political and economic security of Poland after World War II.

No.	Item Name	Curriculum content
21.	Communication Strategy	Characteristics of strategic communication (terminology, essence, responsibility in NATO). Public diplomacy (terminology, essence, structures). Informing the public (terminology, essence, structures). Information operations (methods, views of NATO, views and structures of the USA, Polish views). Psychological operations (methods and techniques of action, US structures, German structures, Polish structures, British structures).
22.	Political sector Security	Political security. Concepts. Political security in security sciences. Forms and types of political threats as well as determinants and research of political security. A model of institutionalization of political security. The need for citizen security and the tasks of a democratic state. The crisis of civic identity. Power as a factor of security. Security strategy as an instrument of political security. The influence of interest groups on political decisions. Media – shaping public opinion. The basic dilemma of political security.
23.	Shaping Security Military in the 21st century	Characteristics of military security of selected states and associations of states in relation to the methodology of identification and description of challenges, and thus potential opportunities and threats to the existence and development of individual societies. The terminology of military security, the components of this security, the impact of these elements on the state and process of military security in the face of identified and described challenges (opportunities and threats) in the perspective of the current century.
24.	Safety Information	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPauduli, Biby, Shiver-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
25.	The economic dimension of safety	Defining economic security and its dimensions. Economization of state security. Typology of threats to economic security. The state and the national economy in the face of contemporary cultural and civilizational changes. Economic aggression in international relations. Financial crises. Activities of transnational corporations. Technological espionage as a threat to economic security. State activity to ensure economic security.
26.	Safety Energy facing Transformation socio-economic	The impact of socio-economic transformation on the functioning of the energy sector of developing and developed countries, and thus also on the energy security of these countries. A parallel process of influencing the way the energy industry operates, as well as the functioning of the energy security sector to protect the industry against threats (both old and new, generated by current socio-economic changes).
27.	Social Conditions Security modern states	The essence of social security. Social security and the model of the state system. Mechanisms shaping social security. Concepts of social security. Models of social security in the EU. Problems of social security in Poland and ways to overcome them. EU activities for social security.
28.	Combating and corruption prevention	Seminar classes. Threats to state security caused by corruption behaviors. Forms of corruption and the offences associated with them. Legislative activities and services responsible for combating and reducing corruption and the principles of building effective anti-corruption solutions in public organizations and in the private sector.
29.	Operational methods of combating serious criminal crime	Seminar classes. Statutory operational methods, i.e. operational control, covertly supervised shipment, controlled purchase and controlled giving/acceptance of financial benefits, used to combat and prevent serious criminal crime. The rules for granting consent to the use of the indicated tools for combating this type of crime and the use of evidence obtained in this way in criminal proceedings. Methods of controlling the use of such non-procedural measures to ensure state security.
30.	Safety Organic on a global scale regional and national	Types of challenges (opportunities and threats) generated by climate change in the area of environmental security. Identification of the impact of climate change on the national security of selected societies on a national, regional and global scale.

No.	Item Name	Curriculum content
31.	Cultural security factors	Culture: concept, categories, identity. Cultural security: conceptual aspects, cultural security in the area of spiritual culture, security in the area of material culture. Cultural threats to the security of the Republic of Poland. The cultural security system of the Republic of Poland. Cultural aspects of international relations. The Cultural Background of International Conflicts. Security Culture – National and International Aspects

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology

No. 26/WAT/2023 of 23 February 2023

amending the resolution on the establishment of the "Curriculum of education at the Doctoral School of the Military University of Technology"

Pursuant to § 21(1)(21) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is hereby resolved:

§ 1

The following changes are made to the Curriculum of the Doctoral School of the Military University of Technology, which is an annex to the Resolution of the Senate of the Military University of Technology No. 8/WAT/2021 of 25 February 2021 on the establishment of the "Curriculum of Training at the Doctoral School of the Military University of Technology":

1) the words *'automation, electronics and electrical engineering'* are replaced by the words *'automation, electronics, electrical engineering and space technologies'*;
2) the words "civil engineering and transport" shall be replaced by the words *"civil engineering, surveying and transport".*

§ 2

The resolution enters into force on the day of its adoption, with effect from 11 November 2022.

President of the Senate

/--/ Brig. Gen. Prof. Przemysław Wachulak

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 10/WAT/2022 of 24 February 2022

on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology"

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended), in connection with § 21(1)(21) of the Statute of the Military University of Technology constituting an appendix to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is resolved:

§ 1

The "Education program at the Doctoral School of the Military University of Technology" *is hereby established,* constituting an attachment to the resolution.

§ 2

The curriculum referred to in § 1 is in force from the academic year 2022/2023.

§ 3

Doctoral students of the Doctoral School of the Military University of Technology who started their education before the academic year 2022/2023 may update their Individual Education Programmes on the basis of this programme.

§ 4

The resolution shall enter into force on the date of its adoption.

President of the Senate

(-) Col. Professor Przemysław Wachulak, PhD, DSc, Eng.

Attachment to the Resolution of the Senate of the Military University of Technology No. 10/WAT/2022 of 24 February 2022

CURRICULUM

AT THE DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

I. General principles

1. The curriculum at the Doctoral School of the Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics and electrical engineering** - a field of engineering and technical sciences;
    2) **technical informatics and telecommunications** - a field of engineering and technical sciences;
    3) **civil engineering and transport** - a field of engineering and technical sciences;
    4) **materials engineering** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security sciences** - a field of social sciences;
    7) **Chemical sciences** - a field of exact and natural sciences.
2. The learning outcomes take into account the requirements specified for the 8th level of the Polish Qualifications Framework.
3. Number of semesters: **8**
4. Number of ECTS credits – min. **30 points**
5. The number of compulsory courses is 100 hours and 20 hours of practical training carried out in the form of conducting classes or participating in them and corresponds to a total of 10 ECTS credits, and the number of optional courses is at least 200 hours and corresponds to at least 20 ECTS credits**.** Optional courses may include classes in subjects carried out at MUT from the optional module of at least 100 hours and 10 ECTS credits, courses carried out at another university or scientific institution in Poland or abroad, and other forms of education, e.g. apprenticeships, internships at and outside the Military University of Technology, in particular at another university or institution in Poland or abroad.
6. Language of conducting:
    a. **Polish or English –** only in the case of subjects, internships or other forms of education indicated in the Individual Education Programme (IPK),
    b. **English –** in the case of education in a scientific discipline in English.
7. The program is valid from: **academic year 2022/2023.**
8. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:
   Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is the professional preparation of future staff in the fields of engineering and technology, exact and natural sciences and social sciences, in particular in the field of military technology and security technology. The task of the Doctoral School is to provide doctoral students with the latest knowledge, shape skills and improve competences at the highest level, as well as cultivate patriotic

traditions and responsibility for the Homeland in broadly understood aspects, both military and civilian, in accordance with the principle "Omnia Pro Patria" – "Everything for the Homeland". The activities of the Doctoral School correlate with the strategic objectives of the Academy's development in terms of strengthening the position of the Military University of Technology in the system of Polish and European higher education, including as the leading educational pillar of higher military education and the expert and research base of the Ministry of National Defense, as well as other ministries. In addition, it emphasizes the elite nature of the Academy as a university conducting innovative teaching and scientific activities, also developing international cooperation in this field.

9. Prerequisites for the candidate for the Doctoral School

   The candidate should have a Level 7 qualification. Polish Qualifications Framework (Master's degree, Master's degree or equivalent) and complete a Master's degree in a field related to the scientific discipline conducted at the Doctoral School or have scientific achievements in this discipline. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may admit a person who is a graduate of first-cycle studies or a student who has completed the third year of uniform master's degree studies. Detailed requirements are set out in the rules of recruitment to the Doctoral School established annually by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for subjects for which the university learning outcomes are required;
2) in the description *component code* column - reference of the assumed learning outcome to the appropriate code of the description component of the first- and second-cycle learning outcomes at level 8 of the Polish Qualifications Framework (PQF 8).
3)

Effect number symbols	**Expected learning outcomes**	**code description component**

Effect number symbols	Expected learning outcomes	code description component
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_W P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
Skills: the graduate is able to		
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8U_U P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8U_U P8S_UW*
D_U03	*independently plan and act for their own development and inspire and organize the development of others,*	*P8U_U P8S_UU*
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks , in particular:* *− define the purpose and object of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8U_U P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8U_U P8S_UK*
D_U10	*participate in scientific discourse, exchange of experiences and ideas, also in the international environment*	*P8U_U P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*

Effect number symbols	Expected learning outcomes	code description component
D_U13	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*
	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_K* *P8U_KK*
D_K02	*taking into account the challenges in the professional and public sphere, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_K* *P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8U_K* *P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8U_U* *P8S_KK*
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8U_U* *P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8U_U* *P8S_KO*
D_K07	*initiating activities in the public interest*	*P8U_U* *P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8U_U* *P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including:* *− conducting scientific activity in an independent manner,* *− respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8U_U* *P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- completion of courses included in the Basic Module, including a doctoral seminar in the subject Analysis of the research area,
- credit for courses from the Optional Module of a discipline or scientific disciplines, professional practice and subjects carried out outside the Military University of Technology and other forms of education[1] included in the Individual Education Program (IPK),
- positively assessed by the supervisor of the doctoral dissertation.

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.
2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.

[1] if they appear in IPK

3. The curriculum includes at least 300 hours of classes[2] and at least 20 hours of professional internships in the form of conducting classes or participating in them - at least 30 ECTS credits in total.
4. The doctoral student's education program consists of:
    1) the basic module for doctoral students of all scientific disciplines conducted at the Doctoral School, 100 hours with a total of 9 ECTS credits;
    2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned, subject to sections 6, 7 and 8;
    3) 20 to 180 hours of practical training in the form of classes or participation in classes from the third to the seventh semester of education – max. 60 hours per year (in accordance with an individual curriculum), which are assigned 1 ECTS credit, regardless of the number of hours of practical training.
    4) optionally, courses taught outside the Military University of Technology and other forms of education on an hourly basis and the number of ECTS credits specified in an individual curriculum.
5. A doctoral student is required to complete the basic module and 20 hours of professional practice in the form of conducting classes or participating in them. A doctoral student, in consultation with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. It is allowed for courses to come from different scientific disciplines and to be taught at another university or research institution.
6. In the case of planned courses outside the Military University of Technology and other forms of education (e.g. internships, internships at and outside the Military University of Technology), the supervisor determines the number of ECTS credits and the learning outcomes to be achieved, provided that the number of hours of classes in the optional module cannot be less than 100 hours and 10 ECTS credits.
7. In the case of education for foreigners in English, the subjects included in the basic module referred to in Chapter V, concerning the issues of Polish regulations, may be replaced by other subjects. Decisions on the introduction of new subjects are made by the Director of the Doctoral School in consultation with the Chairman of the Scientific Discipline Council, within which the education of foreigners is conducted.
8. The implementation of the education programme, taking into account the provisions of sections 5-7, should ensure that the candidate achieves the assumed learning outcomes specified in Chapter II.
9. By the end of the first semester of education, the doctoral student submits an individual education program to the director of the Doctoral School, agreed with the supervisor.
10. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year, subject to paragraph 11

[2] classes may include courses taught outside the Military University of Technology and other forms of education

11. Classes for foreigners providing education in English may be planned centrally or as part of a scientific discipline, taking into account the subjects referred to in paragraph 7.
12. Classes in the subjects of the optional module are planned according to individual curricula.

V. Modules of the curriculum

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, obligatory for doctoral students of all disciplines[3] (I-II sem.)				
1.	Higher education	20	1	*D_WWAT01, D_W05, D_W06, D_UWAT01, D_U03, D_K01, D_K02*
2.	Rules for conducting classes	10	1	*D_WWAT01, D_UWAT01, D_U03, D_U13, D_K01, D_K06*
3.	The process of applying for research funding	10	1	*D_K01, D_K03.D_K04*
4.	Organizational, legal and ethical aspects of scientific work. Self-presentation of a scientist.	10	1	*D_W06, D_U12,*
5.	Methodology of conducting scientific research	10	1	*D_WAT02, D_U01-U05*
6.	Ownership and commercialisation of research	10	1	*D_W05, D_W06,D_U06*
7.	Scientometrics and bibliometrics in scientific activity	4	1	*D_W05, D_U08, D_K03, D_K04*
8.	Principles of writing a scientific paper	6	1	*D_W05, D_W06, D_U07*
9.	Analysis of the research area[4]	20	1	*D_W01, D_W02, D_W03, D_W4, D_U08*
Optional modules related to the scientific discipline (III-VII sem.)				
1	Automation, Electronics & Electrical Engineering	min. 200 hrs[5]	min. 20 points	*List of items attachment V.1 - page 11*
2	Informatics and Telecommunications			*List of items attachment V.2 - p. 13*
3	Civil Engineering and Transportation			*List of items attachment V.3 – p. 15*
4	Materials Science			*List of items attachment V.4 - page 16*
5	Mechanical Engineering			*List of items attachment V.5 – page 18*
6	Chemical Sciences			*List of items attachment V.6 – p. 21*
7	Security Sciences			*List of items attachment V.7 - p. 22*
Internships at WAT (III-VII sem.) - in accordance with the individual education program				
1	Internships in the form of conducting classes or participating in them	20-180 hours	1	*D_WWAT01, D_UWAT01 D_K01*
Subjects taught outside the Military University of Technology and Other forms of education (III-VII sem.) **-** Optionally according to the individual training program				
1	Subjects outside MUT and, for example, internships, internships carried out at and outside MUT at another university or scientific institution in Poland or abroad	*The number of hours, ECTS credits and reference to learning outcomes is determined by the supervisor in an individualised learning programme*		

[3] in the case of education for foreigners in English, the subjects included in the basic module, concerning the issues of Polish regulations, may be replaced by other subjects determined by the Director of the Doctoral School.

[4] course carried out on an individual basis with a supervisor or supervisor and assistant supervisor completed with a doctoral seminar

[5] the minimum number of hours in an optional module may be reduced by pursuing other forms of education, the sum of ECTS credits for an optional module and other forms of education may not be less than 20 points, while maintaining at least 100 hours of an optional module

VI. Framework Programme

The framework programme includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

Lp.	Name Item /discipline Scientific	Curriculum content
Basic module, compulsory for all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Policy conducting classes	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	Process Inference for financing Research	The process of applying for funding for basic scientific research. Statutory activities, financing of domestic and foreign scientific internships for young scientists starting their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Education and Science, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Organizational legal and ethical aspects of work Scientific. Self-presentation Researcher.	Organization of research activities at the university on the example of the Military University of Technology. A model of scientific career in Poland. Parametric evaluation of an academic teacher and a research unit (discipline). Foreign internships and scholarships as part of a scientific career. Formal and substantive activities for the implementation of the doctoral dissertation. Principles of ethics in scientific research and in scientific careers. Principles of self-presentation during the defense of the doctoral dissertation and in the scientific career.
5.	Methodology Conduct research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that requires a solution – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6.	Proprietary Rights and commercializatio n Research	Basic information on the methods of intellectual property protection, in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection. Issues of commercialization of the results of scientific research and development works.
7.	Scientometrics I Bibliometrics in the activity Scientific	Scientometric and bibliometric indicators used in international bibliographic databases (Scopus, WoS), as well as national requirements related to the evaluation of researchers. Dissemination of scientific activities and research results, with particular emphasis on open access policy. The use of bibliographic databases and e-sources in scientific research. Tools supporting the collection of materials supporting the writing of scientific papers.
8.	Writing rules scientific work	Types of doctoral dissertations, requirements for doctoral dissertations, structure of a doctoral dissertation, edition of a doctoral dissertation, examples of doctoral dissertations, examples of reviews of doctoral dissertations.

Lp.	Name Item /discipline Scientific	Curriculum content
9.	Area Analysis Research	Seminar classes supervisor – PhD student. Analysis of the state of knowledge in the field of research issues selected by the doctoral student. Literature review. Defining the research problem (goal, research questions, hypotheses) and preliminary determination of the methodology. Preparation of a presentation for the first doctoral seminar. Preparation of a draft of an individual education program.
Optional modules related to the scientific discipline		
1	Automation, Electronics & Electrical Engineering	*Annex VI.1 – page 24*
2	Informatics and Telecommunications	*Annex VI.2 – page 31*
3	Civil Engineering and Transportation	*Annex VI.3 – page 44*
4	Materials Science	*Annex VI.4 – page 44*
5	Mechanical Engineering	*Annex VI.5 – page 50*
6	Chemical Sciences	*Annex VI.6 – page 59*
7	Security Sciences	*Annex VI.7 – page 62*

VII. Organisation of apprenticeships and other forms of education

Internships are carried out in the form of teaching classes or participation in conducting them for a minimum of 20 hours in semesters III - VII.

In special and justified cases (e.g. disability of a doctoral student), the supervisor may exempt the doctoral student from the obligation to undergo professional practice by indicating an additional optional subject or another form of education in the amount of at least 2 ECTS credits.

From the third to the seventh semester, it is allowed to carry out other forms of education, i.e. internships (other than teaching classes or participating in their conduct), internships in and outside the Military University of Technology, m.in. at a university, a domestic or foreign scientific institution, institutions and enterprises whose scope of activity is related to the subject of the doctoral dissertation. Other forms of education, their number of hours and the allocation of ECTS credits are decided by the supervisor in the Individualised Education Programme.

Apprenticeships and other forms of education are subject to credit for the descriptive grade (*zal / nzal*) in the academic year in which they took place in accordance with the rules set out in the Regulations of the Doctoral School of the Military University of Technology.

VIII. Educational plan

The education plan consists of a general part for all doctoral students of the year, and an individual education plan for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

The Individual Education Plan for Doctoral Student Semesters III to VIII is created on the basis of the Individual Education Programme.

PLAN KSZTAŁCENIA W SZKOLE DOKTORSKIEJ
WSZYSTKIE DYSCYPLINY NAUKOWE PROWADZONE W SZKOLE DOKTORSKIEJ

	moduły/*przedmioty*	ogółem godzin/ pkt ECTS		liczba godzin/pkt ECTS w semestrze:													
				I		II		III		IV		V		VI		VII		VIII	
		godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS
Moduł podstawowy, obowiązkowy dla wszystkich dyscyplin																			
	Ogółem	**100**	**9**	**50**	**3**	**50**	**6**												
1	**Dydaktyka szkoły wyższej**	**20**	**1**	**20**	**1**														
2	**Zasady prowadzenia zajęć dydaktycznych**	**10**	**1**	**10**	**1**														
3	**Proces wnioskowania o finansowanie badań naukowych**	**10**	**1**			**10**	**1**												
4	**Organizacyjne, prawne i etyczne aspekty pracy naukowej. Autoprezentacja naukowca**	**10**	**1**			**10**	**1**												
5	**Metodologia prowadzenia badań naukowych**	**10**	**1**			**10**	**1**												
6	**Prawa własności komercjalizacja badań naukowych**	**10**	**1**			**10**	**1**												
7	**Zasady pisania pracy naukowej**	**6**	**1**			**6**	**1**												
8	**Naukometria i bibliometria w działalności naukowej**	**4**	**1**			**4**	**1**												
9	**Analiza obszaru badawczego**	**20**	**1**	**20**	**1**														
Moduły fakultatywne związane z dyscypliną naukową - 288 przedmiotów																			
1	**Automatyka, elektronika i elektrotechnika - 51 przedmiotów**	**min. 200 godz.***	**min. 20 pkt ECTS***					**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
2	**Informatyka techniczna i telekomunikacja - 40 przedmiotów**																		
3	**Inżynieria lądowa i transport - 27 przedmiotów**																		
4	**Inżynieria materiałowa - 39 przedmiotów**																		
5	**Inżynieria mechaniczna - 80 przedmiotów**																		
6	**Nauki o bezpieczeństwie - 31 przedmiotów**																		
7	**Nauki chemiczne - 20 przedmiotów**																		
Praktyki zawodowe																			
1	*Praktyki zawodowe w formie prowadzenia zajęć lub uczestnictwa w ich prowadzeniu*	**20-180**	**1**					**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
Przedmioty realizowane w innej uczelni lub instytucji naukowej krajowej lub zagranicznej - opcjonalnie zgodnie z IPK																			
1	*Przedmioty realizowane w formie bezpośredniej i zdalnej*	***zgodnie z IPK***						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
Inne formy kształcenia - opcjonalnie zgodnie z IPK																			
1	*np. praktyki, staże realizowane w i poza WAT, w innej uczelni lub instytucji naukowej krajowej lub zagranicznej*	***zgodnie z IPK***						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											

** Suma punktów ECTS w ramach IPK musi wynosić min. 21 punktów, min. liczba godzin w Module fakultatywnym może być zmniejszona do 100 godz. i 10 pkt. poprzez realizację przedmiotów poza WAT i innych form kształcenia, którym przyporządkowano liczbę godzin i punktów ECTS*

IX. Internal system for ensuring the quality of education at the Doctoral School

The internal education quality assurance system at the Doctoral School is an element of the Education Quality Assurance System at the Military University of Technology.

As part of the preparation of doctoral students for high-level research work, the importance of continuous monitoring and systematic improvement of the quality of their education increases. The education quality policy, resulting from the mission and development strategy of the Academy, is implemented at the Academy by setting appropriate goals and quality standards, as well as by implementing, continuously monitoring and improving the internal quality assurance system.

The scope of the internal education quality assurance system at the Doctoral School includes in particular:

1) monitoring and analysis of the formal and legal side of the teaching process;
2) periodic review and updating of education programs;
4) analysis of the conditions for the implementation of the teaching process;
5) monitoring factors affecting the quality of education;
6) analysis of the functioning and development of methods for improving the quality of education.

Annex V.1

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Computer Network Administration	20	3	*D_W03*	*winter*
2.	Computer-aided analysis of experimental data	30	3	*D_W03, D_U06*	*winter*
3.	Smart Antennas	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
4.	Digital Image Processing	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
5.	Optical Radiation Detectors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
6.	Electromechanical energy and signal converters	30	3	*D_W01, D_U05*	*winter*
7.	Laser Physics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
8.	Physics of laser media	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
9.	Photovoltaics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
10.	Supercontinuum Radiation Generation	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
11.	Imaging Information Engineering	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
12.	Encoding and recognition of radio transmissions	30	3	*D_U05*	*winter*
13.	Crystallography	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
14.	Laser absorption spectroscopy in gas sensors	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
15.	Laser-plasma radiation sources X-ray and extreme ultraviolet (EUV)	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
16.	Lasers for medical applications	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
17.	Pico- and femtosecond lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
18.	Fiber lasers	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*leni*
19.	Mathematical models of the electromagnetic field	20	2	*D_W02, D_W03*	*winter*
20.	Finite Element Method	30	3	*D_W02, D_W03*	*lukewarm*
21.	Methods of analysis and measurement of random signals	30	3	*D_W02, D_U05*	*lukewarm*
22.	Data mining methods and tools	30	3	*D_W02, D_W04*	*winter*
23.	Methods of logical synthesis	30	3	*D_W02, D_W03*	*winter*
24.	Surveying and optoelectronic measurements	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
25.	Nonlinear Laser Conversion	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
26.	Scientific and engineering calculations	30	3	*D_W04*	*winter*
27.	Optoelectronics in safety systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
28.	Laser optics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
29.	Coherent Light Optics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
30.	Plasma in science and technology	30	2	*D_W01, D_W02, D_W03*	*winter*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
				D_U010, D_K03, D_K05	
31.	Remote Sensing Basics	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
32.	Designing safety systems	30	3	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
33.	Programmable and Purpose-Built Circuits	30	3	*D_W01, D_U05*	*lukewarm*
34.	Acoustic sensors	20	2	*D_W04, D_W05*	*winter*
35.	Microwave sensors in radiolocation	20	2	*D_W02, D_U04*	*lukewarm*
36.	Smart radio networks	20	2	*D_W01, D_W03*	*winter*
37.	Optical Spectroscopy for Life Sciences	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
38.	Digital systems in optoelectronic devices	30	2	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*	*winter*
39.	Test and measurement systems in the test laboratory	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
40.	Fiber optic technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
41.	Terahertz technique	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
42.	Information concealment technique (steganography)	30	3	*D_W01, D_W02, D_U05*	*lukewarm*
43.	Field theory	30	3	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
44.	Thermal imaging and infrared technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
45.	Optical Radiation Detection Systems	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
46.	Modern transducers measuring physical quantities	30	3	*D_W01, D_U05*	*winter*
47.	Selected issues of the operation of anthropotechnical systems	30	3	*D_W08, D_U05 i 06*	*lukewarm*
48.	Selected Modeling Issues and simulation of power systems	30	3	*D_W02, D_U04*	*lukewarm*
49.	Advanced microelectronics technologies	30	3	*D_W01, D_U05*	*lukewarm*
50.	Applications of lasers in technology	30	2	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
51.	Advanced techniques for digital system design in FPGAs	30	3	*D_W02, D_W03, D_U07, D_U09, D_K05*	*lukewarm*

Annex V.2

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: technical informatics and telecommunications

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Quantum Algorithms III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
2.	Algorithm Analysis III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
3.	Analysis and synthesis of visual information III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
4.	Next-generation wireless systems (NG)	20	2	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*lukewarm*
5.	ICT Systems Diagnostics III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
6.	Efficiency of ICT systems III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
7.	Elements of forecast theory III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
8.	Software Evaluation III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
9.	Physical Foundations of Quantum Information III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
10.	Computer Graphics III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
11.	Software Quality Engineering III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
12.	Cryptology III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
13.	Mathematical Methods of Decision Support III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
14.	Discrete Mathematics III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
15.	Generative and Aspective Methods in Software Development III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
16.	Numerical methods III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
17.	Multi-Criteria Optimization Methods III	20	2	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
18.	Mathematical Modelling III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
19.	Modeling and verification of ICT networks III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
20.	Modeling Conflict Situations III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
21.	Process modeling, simulation and analysis Business Enterprises III	20	2	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*

lp.	Item Name	numbe r of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
22.	Software Reliability III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
23.	Reliability of Systems III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
24.	Optimization III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
25.	Probabilistic III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
26.	Stochastic Processes III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
27.	Image Recognition and Processing III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
28.	Neural networks and fuzzy logic III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
29.	Smart radio networks	20	2	*D_W01, D_W03,D_U010, D_K03, D_K05*	*winter*
30.	Stochastic Exploitation Models III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
31.	Computer Simulation III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
32.	Database Systems III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
33.	ICT systems III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
34.	Decision support systems III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
35.	Artificial Intelligence III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
36.	Theoretical foundations of computer science III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
37.	Graph and Network Theory III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
38.	Project and Process Management III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
39.	Complex Data Structures III	20	2	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
40.	5G network application for military	30	3	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05*	*lukewarm*

Annex V.3

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: civil engineering and transport

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Safety and reliability of building structures	20	3	*D_W03; D_W05; D_U02; D_K02*	*winter*
2.	Dynamic interaction of building structures with a soil medium	20	2	*D_W02; D_U01; D_K05*	*lukewarm*
3.	Environmental physics	20	2	*D_W03; D_U04; D_K02*	*lukewarm*
4.	Modeling of thermal and humidity processes	20	2	*D_W03; D_U04; D_K03*	*lukewarm*
5.	Identification of loads and structural systems	20	2	*D_W02; D_U02; D_K02*	*winter*
6.	Investment process in the construction industry	20	2	*D_W01; D_U04; D_K05*	*lukewarm*
7.	Mechanics of road and airport runway soil foundations	20	3	*D_W03; D_U02; D_U04; D_K03*	*winter*
8.	Test Methods for Stiffness and Load-Bearing Capacity of Road and Airport Pavements	20	2	*D_W03; D_U07; D_K07*	*lukewarm*
9.	Design methods for folding bridge structures	20	2	*D_W03; D_U01; D_U03; D_K01*	*winter*
10.	Design methods of the experiment	20	3	*D_W02; D_U01; D_K01*	*lukewarm*
11.	Modeling the Behavior of Reinforced Concrete Elements and Structures	20	2	*D_W02; D_U01; D_K01*	*winter*
12.	Geometric and Physical Nonlinearities in Structural Mechanics	20	2	*D_W03; D_U04; D_K05*	*lukewarm*
13.	Explosive effects on defensive structures	20	2	*D_W02; D_U01; D_K05*	*winter*
14.	Scheduling and costing systems for construction works	20	2	*D_W06; D_U06; D_K08*	*lukewarm*
15.	Engineering of building materials	20	3	*D_W04, D_U04, D_K05*	*winter*
16.	Cartographic methods of research	20	2	*D_W02, D_U05, D_U07, D_K03, D_K05*	*lukewarm*
17.	Spatial data exploration	20	2	*D_W02, D_W04, D_UWAT02, D_U01, D_U05, D_K03, D_K05*	*winter*
18.	Data science in geospatial research	20	2	*D_W02,D_W03,D_UWAT02, D_U01, D_U05, D_K03, D_K04*	*lukewarm*
19.	Advanced methods of implementation of studies photogrammetric	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
20.	Programming in spatial information systems	20	2	*D_W02, D_W05, D_U06, D_U10, D_K03, D_K06*	*winter*
21.	Reference systems in geosciences	20	3	*D_W02,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
22.	Global Geodetic Observing System	20	3	*D_W01,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
23.	Modern photogrammetric techniques	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*lukewarm*
24.	Selected numerical methods in geodesy	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
25.	Methods of parallel data processing	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*lukewarm*
26.	Mathematical foundations of digital image processing	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
27.	Numerical methods with linear algebra	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*lukewarm*

Annex V.4

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Structural studies by X-ray diffraction	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
2.	Structural studies by scanning microscopy	20	2	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*	*winter*
3.	Mechanical Properties Testing of Engineering Plastics	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	20	2	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*	*winter*
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	20	2	*D_W01, D_W04, D_U05, D_K03*	*winter*
6.	Semiconductor materials for optoelectronic applications	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
7.	Nano and ultra-crystalline construction materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
8.	Nanoporous anodic aluminum oxide: synthesis, Design & Applications	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U03, D_K01, D_K03, D_K05*	*lukewarm*
9.	Non-telecommunications applications of fiber optics	20	2	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
10.	Measurements of machine and equipment parts with using coordinate measuring techniques	20	2	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*	*lukewarm*
11.	Experiment planning and data analysis with using Origin and Statistica	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
12.	Basic properties of liquid crystals	20	2	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*	*winter*
13.	Keysight Vee and Lab View in Control and data processing	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*	*winter*
14.	Designing technological processes for incremental Direct Deposition methods	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
15.	Dielectric spectroscopy	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*lukewarm*
16.	Structural Determinants of Material Properties	20	2	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*	*winter*
17.	Modern methods of material characterization	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*winter*
18.	Contemporary information imaging systems and directions of their development	20	2	*D_W01, D_W06, D_U01, D_U02, D_U05, D_K03, D_K04*	*winter*
19.	High-energy ball milling and mechanical synthesis	20	2	*D_W01, D_W01, D_U05, D_K03*	*winter*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
20.	Advanced materials for hydrogen storage	20	2	*D_W01, D_W03, D_U01, D_K04*	*lukewarm*
21.	Basics of plasmonics and metamaterials	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
22.	Optoelectronic imaging and information processing techniques	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
23.	Selected Materials and Functional Structures for Photonic Applications	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*lukewarm*
24.	Computer Image Analysis in Materials Science	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*lukewarm*
25.	Additive manufacturing of functional materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
26.	Methods for amplifying light emission from broadband semiconductor nanostructures	20	2	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U07, D_U10, D_K01, D_K03, D_K04, D_K09*	*winter*
27.	Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals	20	2	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U10, D_K03, D_K04, D_K05, D_K09*	*winter*
28.	Modeling of semiconductor devices.	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*winter*
29.	High-entropy alloys – synthesis, structure, research and properties	20	2	*D_W01, D_W01, D_U05, D_K03*	*winter*
30.	Additive manufacturing of phased alloys intermetallic	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
31.	Combinatorial Materials Manufacturing and Testing Engineering	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
32.	Reactive mechanical grinding as a method for the synthesis of modern hydrogen storage materials in the solid phase.	20	2	*D_W01, D_W01, D_U05, D_K03*	*winter*
33.	Additive techniques with elements of reverse engineering	20	2	*D_W02, D_W04, D_UWAT02, D_U03, D_U07, D_K03, D_K05*	*winter*
34.	Overview of additive techniques used in modern technology	20	2	*D_W01, D_W03, D_UWAT02, D_D_U10, D_K03*	*winter*
35.	Selected issues in 3D printing	20	2	*D_W01, D_UWAT02,D_U01, D_U08,D_K04, D_K05*	*winter*
36.	Researcher's workshop 1 – tools for writing scientific texts	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
37.	Researcher's workshop 2 – writing scientific articles	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
38.	Researcher's Workshop 3 – Writing Scientific Articles	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
39.	Quantum mechanics in examples	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*winter*

Annex V.5

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: mechanical engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Numerical Analyses in Load-Bearing Structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
2.	Autonomy of mobile robots	30	3	*D_U04, D_W03, D_K01*	*winter*
3.	Non-destructive testing of aircraft	30	3	*D_W02; D_W05; D_U01; D_K05*	*winter*
4.	Biomechanics of human body movement during a road accident	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*lukewarm*
5.	Construction and operation of industrial robots	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
6.	Digital signal processing	30	3	*D_W01, D_W02, D_W03, D_U04, D_K01, D_K03*	*winter*
7.	Design of experiment	30	3	*D_W04, D_U04, , D_K04,*	*lukewarm*
8.	Dynamics of mechatronic system design	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*	*lukewarm*
9.	Dynamics of car movement	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*	*lukewarm*
10.	Dynamics and modeling of hydrostatic systems	30	3	*D_U04, D_W04, D_K01*	*winter*
11.	Dynamics of multi-member systems	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
12.	Solid collision dynamics	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*winter*
13.	Impulse loads of motor vehicles – selected issues	20	2	*D_W04, D_U04, D_K09*	*winter*
14.	Computer-aided operation of machines	20	2	*D_W02, D_U05, D_K05*	*lukewarm*
15.	Shaping a safe car body	20	2	*D_W01, D_U04, D_K01, D_K05*	*lukewarm*
16.	Composite materials in mechanical engineering	30	3	*D_W01, D_W01, D_U04, D_K01, D_K05*	*lukewarm*
17.	Finite Element Method	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
18.	Methods of analysis of numerical experimental research results	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
19.	Methods of testing the condition of machines	30	3	*D_W03, D_U05, D_K01, D_K03*	*winter*
20.	Experimental methods for investigating the thermophysical properties of solids	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*lukewarm*
21.	Methods and techniques for testing the mechanical properties of materials	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*winter*
22.	Numerical Methods in Engineering Applications	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
23.	Numerical Methods in Mechanical Engineering	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
24.	Methods for designing and optimizing aircraft structures	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*	*lukewarm*
25.	Constitutive Models of Materials in FEM Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
26.	Modelling of heat transfer processes	30	3	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*	*winter*
27.	Modeling and simulation of mechatronics	30	3	*D_W04, D_U04, D_K01*	*lukewarm*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
	issues				
28.	Modeling and simulation of nonlinear mechanical problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
29.	Parametric modeling and structural optimization with FEM	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
30.	Flow modeling	30	3	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
31.	Modeling machine motion	20	2	*D_U04, D_W04, D_K01*	*lukewarm*
32.	Modeling composite structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
33.	Modeling of the Contact Phenomenon in Structural Mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
34.	Modeling and research of the processes of cooperation between the wheel and the road	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
35.	Modeling of car traffic and controls	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
36.	Modern technologies for bonding structural materials	30	3	*D_W01, D_W02, D_U05, D_K01, D_K05*	*lukewarm*
37.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	20	2	*D_U04, D_W03, D_K01*	*winter*
38.	Renewable energy sources	30	3	*D_W06, D_U WAT02, D_K07*	*winter*
39.	CAE Engineering Software	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
40.	Experiment planning and optimization of mechanical objects	30	3	*D_W04, D_U04, D_K05*	*winter*
41.	Basics of road safety	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*winter*
42.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*lukewarm*
43.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*winter*
44.	Fundamentals of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
45.	LabVIEW Basics	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
46.	Starting processes of internal combustion engines	30	3	*D_W04, D_U04, D_K01*	*lukewarm*
47.	Programming of control systems for unmanned working machines and robots	30	3	*D_U04, D_W03, D_K01*	*winter*
48.	Mechatronic sensors	30	3	*D_W03, D_W04, D_U06, D_K01, D_K04*	*winter*
49.	Condition monitoring systems	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
50.	Aircraft Operation Systems	30	3	*D_W03; D_U01; D_K03*	*winter*
51.	Control systems in mechanical engineering	30	3	*D_U04, D_W03, D_K01*	*lukewarm*
52.	Technologies for the production and processing of composite materials	30	3	*D_W01, D_W02, D_U04, D_K01, D_K05*	*lukewarm*
53.	Selected solutions in the field of automotive technology and car motion	20	2	*D_W01, D_W03, D_U04 D_K01, D_K05*	*lukewarm*
54.	Theory and organization of machine operation	30	3	*D_W04, D_U06, D_K03*	*winter*
55.	Thermomechanics of materials and studies of	30	3	*D_W03, D_W04, D_U01,*	*winter*

lp.	Item Name	numbe r of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
	thermophysical properties			*D_K03*	
56.	Tribology	30	3	*D_W03, D_U04, D_K05*	*winter*
57.	Durability of aircraft structures	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
58.	Introduction to the equations of mathematical physics	30	3	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*	*lukewarm*
59.	Modern machine and vehicle drive systems	30	3	*D_W03, D_U04, D_K05*	*winter*
60.	Modern test methods for internal combustion engines and vehicles	30	3	*D_W04; D_U01; D_U02; D_U03; D_U04; D_U05; D_UWAT01;*	*winter*
61.	Selected methods and techniques of temperature measurement	30	3	*D_W03, D_W04, D_U04, D_K05*	*lukewarm*
62.	Selected problems of rocket technology	30	3	*D_W03, D_U04, D_K05*	*winter*
63.	Selected issues of waste gas treatment from motor vehicles	30	3	*D_W01; D_W02; D_W03; D_K03; D_K05; D_U010;*	*lukewarm*
64.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	30	3	*D_W01; D_W02; D_W03; D_U05; D_K01; D_K03; D_K05;*	*winter*
65.	Selected issues of object-oriented programming	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
66.	Fatigue strength and fracture mechanics of materials and structures	30	3	*D_W01, D_U04, D_K01*	*lukewarm*
67.	Advanced methods of manufacturing products from sintered powders	30	3	*D_W04, D_U04, D_K01*	*lukewarm*
68.	Advanced ballistics, modeling, and simulation	30	3	*D_W01, D_U04, D_K01*	*lukewarm*
69.	Advanced Mathematics	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
70.	Advanced modeling in structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
71.	Advanced measurement systems	30	3	*D_W04, D_U04, D_K01*	*winter*
72.	Advanced Materials Testing Methods	30	3	*D_W01, D_W02, D_W04, D_U02, D_U04, D_U05, D_K01, D_K05*	*lukewarm*
73.	Application of experimental mechanics in scientific research 1	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
74.	Application of experimental mechanics in scientific research 2	40	4	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
75.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	30	3	*D_W01, D_W02, D_W03 D_U05, D_K01, D_K03, D_K05*	*lukewarm*
76.	Selected issues of vibration theory	20	2	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
77.	Selected issues in acoustoelectronics	30	3	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*lukewarm*
78.	Numerical methods	30	3	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
79.	Electromagnetic field theory	30	3	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
80.	Quantum mechanics	30	3	*D_W01, D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*

Annex V.6

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: chemical sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Analysis of Chemical Warfare Agents	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*	*winter*
2.	Chemistry and technology of liquid crystal materials	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*	*lukewarm*
3.	Chemistry and technology of high-energy materials	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*	*lukewarm*
4.	Chemical Foundations of Environmental Pollution	20	2	*D_W02, D_W03, D_UWAT02, D_K01, D_K03*	*lukewarm*
5.	Physics and chemistry of carbon materials	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*	*lukewarm*
6.	Physicochemical aspects of the explosion	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*	*lukewarm*
7.	History of chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
8.	Ionization methods in analytics	20	2	*D_W03, D_W04, D_UWAT02, D_K01*	*winter*
9.	Methods for preparing samples for analysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
10.	Spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
11.	Modern nanoporous materials	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*	*winter*
12.	Modern methods of synthesis of functional organic compounds	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*lukewarm*
13.	Signal Processing in Analytical Chemistry	20	2	*D_W03, D_W04, D_U05, D_K03*	*lukewarm*
14.	Synthesis of liquid crystals	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*winter*
15.	Introduction to Spectroscopy	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
16.	Modern analytical chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
17.	Advanced pyrotechnics	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
18.	Application of gas chromatography in physicochemical studies	20	2	*D_W WAT01, D_W01, D_W02, D_U WAT01, D_U WAT02, D_K01, D_K03*	*lukewarm*
19.	Polymer chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
20.	Modeling and simulation computer programs in chemistry	40	4	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*	*winter*

Annex V.7

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: security sciences

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Social research in security sciences	40	4	*D_W WAT01; D_W01; D_W06; D_UO3; D_K03;*	*winter*
2.	Statistical methods in social research	40	4	*D_WO4; D_U O3; D_U04; D_KO1; D K03;*	*lukewarm*
3.	Security risk management	30	3	*D_WO1; D_W03; D_UO3;*	*lukewarm*
4.	Security Systems Project Management	30	3	*D_W03; D_U04; D_K05;*	*lukewarm*
5.	Safety Systems Engineering	30	3	*D_W03; D_W02; D_UO6; D_U10; D_KO5;*	*winter*
6.	Safety propaedeutics	30	3	*D_W02; D W05; D_U01; D_K05;*	*winter*
7.	Strategies and concepts of state security management	30	3	*D_W02; D_U04; D_KO5;*	*winter*
8.	Crisis management in public administration	30	3	*D_WO1; D_W03; D_UO3; D_U12;*	*lukewarm*
9.	Universal safety	30	3	*D_W02; D_W03; D_U01; D_K07;*	*lukewarm*
10.	Internal security	30	3	*D_W02; D_W03; D_KO5; D_KO7;*	*lukewarm*
11.	Survey data analysis	20	2	*D_WO4; D_U04; D_KO1;*	*winter*
12.	Multivariate analyses	20	2	*D_WO4; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
13.	Evaluation research procedures	20	2	*D_WO4; D_U04; D_U05; D_KO1; D K03*	*lukewarm*
14.	Logic and theory of argumentation	20	2	*D_WO4; D_U01; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
15.	Forecasting and simulations in security	20	2	*D_W03; D_W04; D_U WAT01; D_U05; D U13; D_K03; D K04; D K05;*	*lukewarm*
16.	Modern technologies in security	20	2	*D_WO1; D_WO2; D_U WATO1; D_UO6; D K03;*	*lukewarm*
17.	Philosophy of security sciences	20	2	*D_W02; D_W03; D_U01; D_U05; D_KO1; D_K03;*	*winter*
18.	Modern terrorism	20	2	*D_W03; D_W06; D_U05; D_UO8; D_U09; D_KO1; D_KO6;*	*winter*
19.	Morale and Security Culture in National and International Relations	20	2	*D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*	*lukewarm*
20.	Safety history	20	2	*D_W02; D_W03; D_U Wato2; D_U05; D_K03; D_KO9;*	*winter*
21.	Strategic communication	20	2	*D_WO1; D_WO3; D_UO6; D_U10; D_KO1; D_KO5*	*lukewarm*
22.	Political security sector	20	2	*D_WO2; D_WO3; D_UO8D_U12; D_K02;*	*winter*
23.	Shaping military security in the 21st	20	2	*D_W04; D_U WAT01; D_U WAT02; D_U05;*	*winter*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
	century			*D_U13; D K03; D_K04; D_K05;*	
24.	Information security	20	2	*D_W06; D_U01; D_K05;*	*winter*
25.	The economic dimension of safety	20	2	*D_W03; D_U WAT02; D_U05; D_K03; D_K04; D_K05;*	*winter*
26.	Energy security in the face of socio-economic transformation	20	2	*D_W04; D_U WAT01; D_U WAT02; D U05; D_U13; D_K03; D_K04; D_K05;*	*lukewarm*
27.	Social Determinants of the Security of Modern States	20	2	*D_W03; D_W06; D_U04; D_U05; D_KO5; D_K07;*	*winter*
28.	Combating and preventing corruption	20	2	*D_WO1; D_W06; DU01; D U02; DU01; D U12; D_K07; D_K02;*	*lukewarm*
29.	Operational methods of combating serious criminal crime	20	2	*D_WO1; D_W03; DU01; D_U02; D_K07;*	*lukewarm*
30.	Environmental security on a global, regional and national scale	20	2	*D _W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D 1.113; D_K03; D_K04; D_K05;*	*winter*
31.	Cultural security factors	20	2	*D_W03; D_W06; D_U04; D_U07; D_U10; D_K04; D_K05;*	*lukewarm*

Annex VI.1
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics and electrical engineering

Lp.	Item Name	Curriculum content
1.	Administering computer networks	The specificity of the administration process. Network design. Efficient use of the router and transport resources. Network traffic monitoring, practical ways to fix problems. Intra-domain routing. Designing a dedicated network architecture. Evolution of the administration support platform.
2.	Data analysis experimental aided by computer-aided	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of univariate and multivariate data, processing of multidimensional experimental results using linear transformations, problems of discrimination including linear and non-linearly separable problems using simple methods of producing separating hyperplanes, methods of minimum distance classification, nearest neighborhood, k-means and hierarchical grouping.
3.	Smart Antennas	Basic properties of smart antennas. Construction of antenna arrays. Applied solutions for shaping the characteristics of smart antennas. An overview of algorithms used in smart antennas. The principle of operation of adaptive patterns, the properties of their components and the configurations in which they are used in practice. Simulation models of the adaptation process.
4.	Digital Computer vision	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
5.	Detectors Radiation Optical	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, photodiodes p-n, pin, APD, with Schottky barrier, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages.
6.	Electromechanical Energy converters and signals	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements.
7.	Laser Physics	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
8.	Physics Laser Centers	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction. Energy levels of transition group metal ions. Phenomena of energy transfer between ions in active media.
9.	Photovoltaics	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.
10.	Generation Radiation supercontinuum	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the

Lp.	Item Name	Curriculum content
		refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
11.	Engineering image information	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality – key system components, application solutions.
12.	Coding and recognition radio transmissions	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
13.	Crystallography	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
14.	Laser absorption spectroscopy in gas sensors	Gas detection methods and defining gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
15.	Laser-plasma X-ray sources and extreme ultraviolet (EUV)	Methods of producing X-rays and extreme ultraviolet radiation (EUV), basics of laser-generated plasma physics and X-ray and EUV optics, principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), examples of the use of these sources in science and modern technology.
16.	Lasers for medical applications	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications and the therapeutic and diagnostic effects obtained.
17.	Pico- and femtosecond	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
18.	Fiber lasers	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition

Lp.	Item Name	Curriculum content
		group metals - selected issues.
19.	Mathematical Field Models Electromagnetic	Mathematical differential relationships. Distribution. Orthogonal functions in electromagnetic applications. Wave propagation in materials and metamaterials. Analytical models for calculating the radiation field. Potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the far zone criterion for real antennas. Differential equations in electromagnetic problems. Computational electromagnetism - differential methods.
20.	Method finite elements	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
21.	Methods of analysis and measurement of random signals	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
22.	Methods and tools data mining	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
23.	Methods of logical synthesis	Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
24.	Surveying and measurements Optoelectronic	General conditions for carrying out measurements. Optoelectronic measurement sensors basic technical and metrological parameters. Measurement of the power and energy of optical radiation. Testing of optical radiation power and energy meters. Laser distance and speed measurements. Measurement of wavelength and spectrum of optical radiation. Measurement of wavelength and spectrum of optical radiation. Measurements of polarization and coherence (degree of coherence) of laser radiation. Testing the resolving power of the monochromator, testing the spectrum of the selected laser. Lidars in research and their applications. Interferometric measurements. Optoelectronic measurement and recording systems.
25.	Nonlinear Radiation Conversion Laser	Elements of crystallography and crystal optics. Properties of uniaxial and diaxial crystals (KDP, LiJO3, LiNbO3, KTP, BBO, LBO etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector synchronizm. Generation 2□ and summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits.
26.	Scientific and engineering calculations	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
27.	Optoelectronics in systems Security	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.

Lp.	Item Name	Curriculum content
28.	Laser optics	ABCD-2D and 4D methods in geometric and wave optics. Laser beam parameters and methods of their measurement. Gauss-Schell model of laser beam transformation in optical systems. Basics of coupling and shaping laser beams. Properties of the resonator and Fabry-Perot interferometer. Elements of the theory of resonators, mode structure of laser radiation. Thermo-optics components.
29.	Coherent Light Optics	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.
30.	Plasma in science and technology	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
31.	Remote Sensing Basics	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron paramagnetic resonance (EPR) (microwave spectroscopy). Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems. Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.
32.	Designing safety systems	Security strategy and principles for creating technical protections. Normative principles and a set of good industry practices. The range of technical protection measures that can be applied. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor and outdoor applications. Working conditions and restrictions on this account. Structure of the technical and detailed design. The scope of the technical executive design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Rules for detailed design and cost estimation. Design study in the field of technical and detailed design. Required resources to lay the groundwork for the project. Threat analysis. The concept of technical protection of the security system. Rules for conducting a hazard analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. Attack scenarios and verification of the possibility of technical protection against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Methods of description and graphical representation of the technical design. The way documentation is organized. Examples of technical executive designs of critical infrastructure facilities. Documents related to the technical detailed design. Rules for the development of an investor's and "blind" cost estimate. The need to compile technical catalogues and technical data sheets of devices.
33.	ICs Programmable and specialized	Technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). Principles of digital circuit topography design, power distribution and clock distribution, I/O buffers, IP blocks, and design tools.
34.	Acoustic sensors	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
35.	Microwave sensors in radar	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
36.	Smart radio networks	Smart radio network concept. CRAHN ad-hoc networks. CR hardware and software architectures. Semantic context of CR. Problems of teaching in the CR

Lp.	Item Name	Curriculum content
		system. Policies in the CR network. Dynamic spectrum management. Sensing and spectrum sharing. Collaboration and competition in CR networks. Security problems in CR. Standards for CR networks and CR solutions in NG (New Generations) networks
37.	Optical spectroscopy in applications Biomedical	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński diagram Spectroscopic arrangement – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
38.	Digital Systems in the devices optoelectronic	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
39.	Test and measurement systems in the test laboratory	Signal conditioning systems. Control and measurement systems. Measurement signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
40.	Fiber optic technology	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.
41.	Terahertz technique	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
42.	Concealment technique information (steganography)	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of hiding data – cases and scenarios of action.
43.	Field theory	Basic concepts and equations of the theory of the electromagnetic field. Maxwell's equations, Properties of mediums and boundary conditions. Fields at the boundary of medium separation, Electromagnetic field energy. Types of electromagnetic phenomena, Electrostatics and magnetostatics. Stationary and quasistationary electromagnetic fields, Maxwell's equations in complex form for harmonic waveforms, Electromagnetic waves. Wave equation for the area without sources, Uniform plane wave. Propagation parameters of a homogeneous plane wave, Propagation of a homogeneous planar wave in a lossless dielectric, Propagation of a homogeneous planar wave in lossy dielectrics, Propagation of a homogeneous planar wave in a good conductor, Structure of a homogeneous planar wave, Reflection and refraction of a homogeneous planar wave at a planar boundary of two different mediums. Reflection and refraction of a homogeneous plane wave at the boundary of two different dielectrics, Reflection of a homogeneous plane wave propagating in a dielectric from the plane surface of a conductive medium Electromagnetic potentials and radiation, Potentials of alternating fields, delayed potentials. Hertz vector potential, Field of elementary oscillator, Electromagnetic field at short distances from the oscillator, Electromagnetic field at long distances from the elementary oscillator, Wave phase, wave type, phase velocity, Propagation of waves in parallel systems of conductors and in waveguides, Transverse electromagnetic wave TEM, Transverse magnetic wave TM in a rectangular waveguide, Transverse electric wave TE in a rectangular waveguide, Base Type, Cuboid Cavity Resonator

Lp.	Item Name	Curriculum content
44.	Thermal imaging and infrared technology	Application of thermal radiation polarization in thermal imaging. Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Thermal imaging systems supporting the landing of aircraft. Modern infrared sensors with shaped and programmable detection zones. Active thermal imaging, measurement capabilities and prospects for its application. Multiband pyrometry for underwater oil exploration.
45.	Detection systems Radiation Optical	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
46.	Today's size transducers Physical	The concept of a measuring transducer and their classifications. Static and dynamic properties of transducers. Resistance strain gauges. Capacitive, piezoelectric, inductive, magnetoelastic, thermoelectric and pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic and acoustic transducers. Photoacoustic and photonic transducers. Integrated transducers.
47.	Selected issues of the operation of anthropotechnical systems	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
48.	Selected Modeling Issues and simulation of power systems	Power systems as complex organisms of the modern world. The technical, economic and socio-civilizational side of el-en systems. Classification of SEE operating states, typical features. Mathematical models for describing the operating states of power system components and system operating states (quasi-steady states, electromechanical states, technical constraints, models for describing financial flows, for describing the basic conditions of control and regulation structures). A compromise approach to modeling operating states in the area of connections between classically understood SEI and new objects introduced into motion (selected issues). Mathematical methods, in application to the description of the above-mentioned various states of system operation (features, numerical properties, conditions in the field of data streams, scalability, etc.). Simulation and tactical (operational) research in deepening the understanding of processes (operation, development planning, etc.). Mathematical models and methods of searching for system structures leading to the improvement of its functional features (selected issues). Distributed generation, renewable energy sources, WAMS systems, FACTS and D-FACTS systems, microgrids, SmartGrids, involving the consumer side to mitigate risk asymmetry and expand the possibilities of energy storage in the SEI – transformations and possible directions of the evolution of power systems (selected issues). Basic software, selected examples.
49.	Advanced technology microelectronics	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy structure of semiconductors.
50.	Laser applications in technology	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.
51.	Advanced techniques for digital system design in FPGAs	The Advanced FPGA Digital Systems Design Techniques course discusses issues related to, m.in others, the development of integrated digital systems in FPGAs, topographic design, effective use of design constraint attributes, preparation of functional tests, and good design practices. The course is divided into a theoretical part (lectures) and a practical part (laboratories and a project), and the results of the project work carried out are discussed at the seminar.

Lp.	Item Name	Curriculum content
		Before starting the course, it is advisable to

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: technical informatics and telecommunications

Lp.	Item Name	Curriculum content
1.	Quantum Algorithms III	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	Algorithm Analysis III	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	Analysis and synthesis visual information III	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	Next-Generation Wireless Systems (NG)	Development trends. Networking. Radio interface techniques. Development trends. Networking. Radio interface techniques. Development of services and applications. Organization and management in NG systems. Applications of artificial intelligence (AI) and machine learning (ML). Bulk systems, D2D (Device-to-Device) systems, transport systems. Cognitive NG networks. Green communication.
5.	ICT Systems Diagnostics III	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
6.	Efficiency of ICT systems III	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
7.	Elements Forecast Theory III	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.

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8.	Software Evaluation III	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation. Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
9.	Physical Fundamentals Quantum Information III	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
10.	Computer Graphics III	Introduction to computer graphics, basic applications - computer animation, visual simulation, AR and VR systems. Vector graphics, raster graphics - representation of image data. Basic graphics standards - GKS, PHIGS, OpenGL. Raster algorithms - Bresenham, anti-aliasing, HLHSR. Geometric modeling - curves and surfaces, 3D objects. Geometric transformations - translations, rotations, scaling, projection. Color modeling - color perception, CIE, RGB, HLS, HSV(B) color models, color space transformations. Lighting modeling - lighting models, shading algorithms, raytracing, radiosity. Texture Modeling - Defining, mapping, and filtering textures.
11.	Quality Engineering software III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
12.	Cryptology III	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
13.	Mathematical Methods of Decision Support III	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the

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		Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-making under uncertainty. Methods of determining the representation of sets of irreparable decisions. Methods for determining "approximate sets of optimal solutions". Examples of modeling decision support processes.
14.	Discrete Mathematics III	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers. Break down the number into its components. Asymptotics. Creating functions. Asymptotic notations. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
15.	Generative methods and aspect in the manufacture of software III	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
16.	Numerical methods III	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
17.	Multi-Criteria Optimization Methods III	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
18.	Modeling Mathematics III	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin, maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of

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		indistinguishability. Lower and upper approximation of the set. Approximation accuracy. Optimal decisions with approximate data knowledge. Decision boards. Deterministic and non-deterministic rules. Uncertain variables.
19.	Modelling and network verification ICT III	Basics of verification of ICT systems (ST) based on formal models: model verification, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-2, CPN Tools, UPPAAL.
20.	Modeling Conflict Situations III	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
21.	Process modeling, simulation and analysis Business Enterprises III	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
22.	Reliability software III	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and programmatic methods of shaping reliability software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability indicators, finite error models, infinite error models. Models in the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1-1988, IEEE/ANSI Std 982.2-1988.
23.	Reliability of Systems III	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with

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		zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for renewable facilities with zero renewal. Reliability of renewable facilities with non-zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of reliability structures. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
24.	Optimization III	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
25.	Probabilistic III	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.
26.	Stochastic Processes III	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
27.	Recognition and image processing III	Introduction to the issues of digital recognition and image processing. Basic problems related to digital image acquisition and how to solve them. Frequency methods in digital image processing. Basics of using transforms in digital image processing and analysis. Spatial methods in digital image processing. Improving the quality of images with the use of convolutional, ranking, logical filters - their advantages, disadvantages, ways of implementation. Introduction to digital image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Basic methods of image identification: classification in the space of features, structural method.
28.	Neural networks and fuzzy logic III	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
29.	Smart radio networks	Smart radio network concept. CRAHN ad-hoc networks. CR hardware and software architectures. Semantic context of CR. Problems of teaching in the CR system. Policies in the CR network. Dynamic spectrum management. Sensing and spectrum sharing. Collaboration and competition in CR networks. Security problems in CR. Standards for CR networks and CR solutions in NG (New Generations) networks
30.	Stochastic Exploitation Models III	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of

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		basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
31.	Computer Simulation III	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simulation systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
32.	Database Systems III	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
33.	Systems ICT III	Route and link availability control in the LAN environment: LAN link availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol: the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IPSec protocol, MPLS-based VPNs.
34.	Decision support systems III	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
35.	Artificial Intelligence III	Paradigms of artificial intelligence and areas of its applications, limitations of artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate

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		calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search, simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
36.	Theoretical foundations of computer science III	Algorithmic theory of information. Accuracy and correctness of algorithms. Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transformations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
37.	Graph and Network Theory III	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. Complex graph as a special type of graphs. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms. Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
38.	Project management and Processes III	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of projects and processes, planning the usability and functionality of project

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		processes, planning the reliability of project activities, planning of control and verification of results, project risk management. Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the enterprise, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, management of communication in the project, methods and techniques of process improvement, models of process management development. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of the rhomboid model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
39.	Complex Data Structure III	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.
40.	5G network application for military	5G network technologies. 5G use cases and system concept. 5G Network Architecture. 5G architecture elements and functionalities/roles. Millimeter wave communications. Device-to-device (D2D) communications. The 5G radio-access technologies. Machine-type communications. Massive multiple-input multiple-output (MIMO) systems. 5G Network Miltary Gaps. Sensors and effectors. Military scenarios (use cases). 5G network Military Application and use cases:. 5G network in Spectrum Situation Awareness application (workshop). 5G network Military Application and use cases:. (own work/seminar/workshop with teacher support).

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering and transport

Lp.	Item Name	Curriculum content
1.	Safety and reliability of building structures	Knowledge in the field of safety and reliability of building structures. Classifications and rules for shaping the load-bearing structures of buildings and the conditions for assessing their safety. Methods of description and distribution of random variables. Functions of reliability and damage intensity. Methodology for conducting reliability tests, risk assessment, the safety of building maintenance and their effectiveness.
2.	Dynamic interaction of building structures with a soil medium	Methods of formulating computational models of the dynamics of structural elements and systems as well as the soil foundation medium of the building. Determination of the physical characteristics of the soil medium under static and dynamic loads. Influence of the content of the phases on the parameters of the substrate.
3.	Environmental physics	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits. Types of light sources for lighting. Indoor and outdoor illumination, luminous flux, illuminance, luminous efficacy, light source spectrum, standard observer, objective determination of the source color.
4.	Modeling of thermal and humidity processes	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
5.	Identification of loads and structural systems	Identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of the initiating reactions of the supporting systems of objects, which are revealed by static or dynamic displacements or vibration frequencies.
6.	Investment process in the construction industry	Organization of construction investments, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
7.	Mechanics of road and airport runway soil foundations	Modeling of the soil as a single-phase or three-phase continuum depending on the type of soil (cohesive or no-cohesive). Stiffness and load carrying capacity of the ground as the problem of an elastic half-space. Dynamic effects generated by moving loads.
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
9.	Design methods for folding bridge structures	Construction of folding bridges with determination of their technical and operational parameters. Theory of Calculation of Folding Bridges Taking into Account Mounting Clearances for Objects in Static and Dynamic Systems.

Lp.	Item Name	Curriculum content
10.	Design methods of the experiment	The essence of experimental research. Resistance extensometry. Measurements and analysis of measurement errors. Organization of the measurement line. Experimental methods of testing materials in simple stress conditions - tensile, compression, shear, bend, torsion tests. Materials testing in complex stress states. Assessment of rheological properties of materials - creep and relaxation. Optical research methods in mechanics – elastooptics, optical, mesh and holographic interferometry.
11.	Modeling the behavior of elements and structures reinforced concrete	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
12.	Geometric and physical nonlinearities in mechanics Design	Deformations of flaccid structures and bodies with low rigidity, the use of geometric relationships with linear and nonlinear terms. Consequences of deformation in equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.
13.	Explosive effects on defensive structures	Physics of phenomena generated by explosion of explosive charges and fuel-air mixtures. Methods of determining the parameters of explosion loads. Types of mechanisms destroying elements and load-bearing structures of buildings.
14.	Scheduling and costing systems for construction works	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
15.	Engineering of building materials	Contemporary trends in the modification of building, construction and finishing materials. Technologies of preparation, implementation and optimal procedures for incorporating materials and products under building conditions. Structure and material considerations of composites used in construction. The role of additives and admixtures in buildings technologies.
16.	Cartographic methods of research	The use of maps to describe, analyze and scientifically learn phenomena, including cartometric research, mathematical and statistical analysis and methods of mathematical theory of information. Issues related to, among others, distribution analyses (potential maps, concentration analyses), dynamics of phenomena, as well as correlation methods and trend methods.
17.	Spatial data exploration	Review of exploratory data analysis methods with particular emphasis on geospatial data, including classification and grouping, reduction of the number of variables, and spatial pattern discovery. Classification using decision trees and the Byesian classifier, hierarchical grouping, and quality evaluation of classifiers and model validation.
18.	Data science in geospatial research	Advanced geospatial data processing, analysis, and modeling. Searching for trends and dependencies using exploratory data analysis techniques, machine learning and artificial intelligence, m.in.: real estate market, land cover changes, population distribution. The quality of the data and its impact on the effect of forecasting and modeling, as well as effective reporting and visualization of results.
19.	Advanced methods of implementation of studies photogrammetric	Problems of filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF. Fundamental problems of contemporary digital photogrammetry. Digital image acquisition systems – photogrammetric digital cameras and VHRS and Nano satellite systems. Remote sensing and photogrammetric methods of data acquisition. Modern photogrammetric technologies – their applications in the development of site and elevation maps, digital terrain model and orthophotomaps, as well as 3D spatial maps. Application of Computational Intelligence Algorithms in contemporary photogrammetric studies. Characteristics of new multi-image fitting methods. Methodology for developing dense point clouds from images.
20.	Programming in spatial information systems	The use of the programming environment, the concept of procedure, function and instructions for data processing. A way of accessing and processing spatial data directly using programming code. Libraries that enable spatial data processing in the .NET environment, the ability to automate the ArcGIS environment using Python.

Lp.	Item Name	Curriculum content
21.	Reference systems in geosciences	We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference. To be understood in context, when the motion of the Earth's crust is observed, it must be referenced. The global geodetic frame of reference is the fundamental basis for measuring worldwide processes and is crucial for its proper interpretation especially for climatic studies. A terrestrial reference frame provides a set of coordinates of some points located on the Earth's surface. It can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space. This rotation is assessed with respect to a frame tied to stellar objects, called a celestial reference frame. The Earth Orientation Parameters (EOPs) connect these two frames together. Nowadays, four main geodetic techniques are used to compute accurate coordinates: the GPS (Global Positioning System), VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite). They all use networks of stations located on sites covering the whole Earth. Modern realizations are of kinematic type, which means that they include station positions and velocities. They model secular Earth's crust changes that is why they can be used to compare observations from different epochs. The Ph.D. students will learn about advancements of the International Terrestrial Reference System (ITRS) which is a World spatial reference system co-rotating with the Earth in its diurnal motion in space for the geodetic, but also astronomical, and geophysical communities.
22.	Global Geodetic Observing System	Global Geodetic Observing System (GGOS) is the Observing System of the International Association of Geodesy (IAG). GGOS and its related research and services address the relevant science issues related to geodesy, geodynamics and geophysics in the 21st century, but also issues relevant to society, like global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea level estimations and ocean forecasting, or the space weather. The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS mission is to: (i) provide the observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, (ii) provide the global geodetic frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications, and (iii) benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built. Within this subject Ph.D. students will advance their understanding of the dynamic Earth system by quantifying our planet's changes in space and time and learn about the integration within the geodetic, geodynamic and geophysical communities at the highest level, in service to the technical community and society as a whole.
23.	Modern photogrammetric techniques	A modern approach to photogrammetric studies based on the use of the latest techniques of processing imagery obtained from various altitudes and the use of their geometric relationships in the field of situational and elevation measurement in areas including: development and updating of maps, feeding topographic databases, supporting the construction of 3D cadastre, as well as cooperation with mobile systems in the field of building virtual reality at various levels of detail.
24.	Selected numerical methods in geodesy	Practical use of numerical methods to solve scientific and technical problems (geodesy), ideas and concepts of numerical methods, numerical algorithms, programming elements - computational scripts. Use of selected tool libraries of scripting languages such as Matlab, Octave and Scilab.
25.	Methods of parallel data processing	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods and functions of the Parallel Computing and MATLAB Distributed Computing Server Toolbox modules.
26.	Mathematical foundations of digital image processing	Creating gradient and edge filter masks based on differential diagrams constructed using the finite difference method (FDM) and the finite element method (FEM) (convergence, agreement, order of precision, π- as the first form of differential approximation). Spectral properties of masks (matrices of the third and fifth order), including the spectral transfer function and its graphical presentation. The goodness of the mask is defined as the quotient of the spectral transfer function of the filter under study and the visual transfer function of the differential

Lp.	Item Name	Curriculum content
		transfer of the Laplace operator. Operations on masks (addition, subtraction, 45° rotation), determining the form of the differential operator related to the results of these transformations (Laplacian, bi-Laplacian, etc.). Filters that identify only corners (vertices). Bi-Laplacian mask vs. Harris corner detector.
27.	Numerical methods with linear algebra	Vector norm, matrix norm, induced norm. Norm 1, 2 and maximum. Matrix conditioning indicator. The use of linear algebra methods in numerical (differential) solving of mathematical physics problems (advection equation, diffusion, diffusion problem with advection). Convergence and stability of the differential method. Spectral transfer operator. π- a form of the first differential approximation. Numerical diffusion, creation. Analysis of selected differential schemes in terms of spectral properties – explicit, implicit, semi-implicit scheme, Crakn-Nicholson, Crank-Nicholson-Galerkin. Dissipation and dispersion in Lax-Wendroff and Beam-Warming schemes used in civil engineering and trance-sport.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	Curriculum content
1.	Structural studies by X-ray diffraction	Basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	Structural studies by scanning microscopy	Terms used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Preparation used in reflection and transmission electron microscopy. Selected by advanced microscopic methods (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of images and breakthroughs).
3.	Mechanical Properties Testing of Engineering Plastics	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	Physical basis of electro-optical effects in Liquid Crystals (CK). Selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals.
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	Study of materials, in particular materials for storing hydrogen in the solid phase, using: differential calorimetry, thermogravimetry and volumetric analyses. Types of equipment, principles of operation, calibration methods, good practices of use, advantages, disadvantages, possibilities and limitations. Basics of analysis of test results, correction of results and selection of test parameters to obtain the best results.
6.	Semiconductor materials for optoelectronic applications	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic semiconductors).
7.	Nano and ultra-crystalline construction materials	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	Nanoporous anodic aluminum oxide: synthesis, Design & Applications	Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.). Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electrochemical synthesis (temperature, voltage, time). The process of self-organization of the matrix pores into a hexagonal system. Soft anodization. Hard anodization. Pulsed anodization. Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods). Applications of anodic aluminum oxide matrix (biosensors, filters, optoelectronic components, tissue engineering, etc.). New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	Non-telecommunications	Interference (phase) fiber optic sensor technology. Terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the definition of the role of the transducer as well as optical

Lp.	Item Name	Curriculum content
	applications of fiber optics	and electronic signal processing. Methods of building sensors with a point and a distributed detection field. Multiplication of point sensors.
10.	Measurements of machine and equipment parts with using coordinate measuring techniques	Use coordinate measuring techniques and tactile profilometry at various stages of the production process. Metrological properties of coordinate measuring machines and tactile profilometers Programming of a multi-sensor measuring machine to carry out measurements as part of the final acceptance of machine parts and equipment manufactured in mass production conditions.
11.	Experiment planning and data analysis with using Origin and Statistica	The use of computer programs to plan an experiment. Statistical methods. Origin and Statistica's capabilities for experiment planning and data analysis.
12.	Basic properties of liquid crystals	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	Keysight Vee and Lab View in Control and data processing	Basics of programming in LabView, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops (for loop, while), selection structures, feedback, etc. How to use objects of various types (numeric, string, bool), including in the form of matrices and clusters. Methods of data processing and transfer. Creating a program algorithm to control a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Basics of programming in Keysight Vee, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops, selection structures, conditional statements, etc. A way of using objects of various types, including matrices and complex variables. Basic methods of data processing and transfer. Cooperation Keysight Vee – MS Excel. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	Designing technological processes for incremental Direct Deposition methods	Design of elements of machine and equipment parts using solid and surface modeling. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological process design - production of the target production series
15.	Dielectric spectroscopy	Dielectric spectroscopy (impedance spectroscopy/radio range spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics for the analysis of the properties of materials used in electronics. Electrical phenomena at the atomic, molecular, and macroscopic (medium) levels. Theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. Parasitic effects in impedance measurements. Research equipment (impedance analyzers), experiment and analysis of experimental data in the context of the properties of various materials.
16.	Structural Determinants of Material Properties	Terminology, methodology, critical reception of external data, critical evaluation of the results of solving scientific problems in the area of materials and technology. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions.
17.	Modern methods of material characterization	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.
18.	Contemporary information imaging systems and directions of their development	Modern imaging systems for direct observation: liquid crystal, organic LEDs, microleds, flexible and roll-up displays. Discussion of the effects and materials used. The level of solutions achieved, limitations resulting from the physics of effects, material possibilities, available technology. Projection systems used effects, solutions ranging from cinema systems through didactic systems to micro-

Lp.	Item Name	Curriculum content
		projectors. Directions of development of displays and projection systems. Particular emphasis will be placed on combining knowledge about the physical effects used in the construction of displays, new materials (including nano-structures used in LCDs, OLEDs and microLEDs), and the possibilities of modern technology with compliance with environmental protection requirements.
19.	High-energy ball milling and mechanical synthesis	Issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. Types of ball mills, the principle of their operation, capabilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.
20.	Advanced materials for hydrogen storage	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity materials for hydrogen storage. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
21.	Basics of plasmonics and metamaterials	Basic definitions of plasmonics and metamaterials. Physical basics, interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces. Technological conditions for the implementation of metamaterial one-, two- and three-dimensional structures. Physical and technological requirements and limitations for different types of metamaterials, as well as the use of classical technologies for the production of nano- and metamaterials. Methods for simulation of the properties of selected metamaterial and plasmonic structures and methods for characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. Application of metamaterial structures in photonic devices and prospects for the development of nano- and metamaterials with particular emphasis on military applications.
22.	Optoelectronic Imaging and Information Processing Techniques	Colour vision, perception of black-and-white and colour information and the human-display-imaging interdependence, display requirements and ergonomics of various types of imagery. Physical and theoretical basis of the effects used in displays and their determinants. Active displays - fluorescent, plasma, electroluminescent, construction, characteristic parameters, purpose and passive displays - liquid crystal, electrophoretic, structure, parameters and conditions of applications. Segmented and multiplex liquid crystal displays as well as active matrix controlled liquid crystal displays. Projection systems, large-format displays, purpose, advantages, disadvantages. Organic and inorganic materials for displays and characteristics of their properties and elements of display manufacturing technology as well as characteristics of technological processes, methods of control and evaluation of display performance parameters. Methods of three-dimensional imagery, methods of implementation and application, teleimmersion.
23.	Selected Materials and Functional Structures for Photonic Applications	Properties and applications of such materials and structures as: optical glass and polymer substrates for the construction of electro-optical transducers, oxide and organic functional layers used as anti-reflective layers, bandstop and edge filters, transparent conductive organic and inorganic layers, nanomaterials for organic applications, photonic polymers and liquid crystals, including composite structures. Construction, construction and operation of selected photonic elements, made on the basis of, among others. the above-mentioned functional materials; spatial light modulator, dynamic wave plates, dynamic elements of diffraction optics (diffraction gratings), optical vortices, microlasers based on self-organizing structures, Kerr and Pockels cells, optical materials and elements for spatial imaging and others.
24.	Computer Image Analysis in Materials Science	Basics of stereology, including basic assumptions and stereological implementations. Detection methods and binarization procedures necessary for quantitative image analysis. Fundamentals of image acquisition and processing (m.in. morphological transformations, logical and arithmetic operations). Procedures carried out during computer image analysis in the study of real engineering materials.
25.	Additive manufacturing of functional materials	Practical aspects of additive manufacturing of functional metallic materials using LMD/LENS laser technology. Influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of functional materials.
26.	Methods for amplifying	Basic types of broadband semiconductors. Properties of luminescent broadband

Lp.	Item Name	Curriculum content
	light emission from broadband semiconductor nanostructures	semiconductors on specific examples (e.g. GaN, ZnO, SnO2). Methods of synthesis of nanostructures. Modulation of optical properties of nanostructures at the synthesis stage. Post-synthetic methods of luminescence enhancement. Intentional doping of broadband semiconductors. The phenomenon of charge and energy transfer. The phenomenon of surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR). Plasmonic light gain from semiconductor nanostructures – basic criteria for coupling SPR or LSPR to the frequency of optical transitions in semiconductors at the metal/semiconductor interface.
27.	Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals	Basic knowledge of the production of porous anodic aluminum oxide (AAO). Parameters of electrochemical synthesis. The phenomenon of constructive and destructive interference. Single-layer and multi-layer interference. Features of an ideal anti-reflection coating. Anti-reflective coatings with graded refractive index. Microstructure of the moth eye. Surface wettability. High-energy vs. low-energy surfaces. Hysteresis of the contact angle. Wetting textured surfaces: Wenzel model vs. Cassie-Baxter model. General characteristics of 1D, 2D and 3D photonic crystals. Structural coloration. Inspirations drawn from nature, or what is biomimetics. Multi-stage electrochemical synthesis of AAO with conical pore shapes. Electrochemical production of 1D crystals by pulsed method. Design of voltage or current pulse sequences, taking into account processes limited by diffusion and the speed of ion transport through the barrier layer. Control of electrochemical synthesis parameters to obtain the desired photonic properties of AAO-based photonic crystals.
28.	Modeling of semiconductor devices.	The genesis of transport equations derived on the basis of the principles of behavior and postulates of thermodynamics of irreversible processes. Generation-recombination mechanisms responsible for the magnitude of charge carrier concentration. Contribution of cross-band processes and SHR mechanisms involving point defects, dislocations and surface states. Process modeling and determination of cross-sections. Mechanism of interband absorption of radiation. Construction of iterative diagrams enabling numerical solving of a system of transport equations. Record on the numeric grid. Problems related to numerical solving of nonlinear equations. He will be able to write a fragment of the program as a task to pass the subject. This fragment can be implemented into my program in order to design a specific device or to study the physical parameters of the structure.
29.	High-entropy alloys – synthesis, structure, research and properties	The latest group of materials – the so-called high-entropy alloys. Theoretical aspects of their formation and stability, properties, structure, synthesis methods and heat treatment. Practical attempts to synthesize and study the properties of alloys from this group.
30.	Additive manufacturing of phased alloys intermetallic	Specific aspects related to the additive manufacturing of alloys based on intermetallic phases (in particular FeAl). The influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of these materials.
31.	Combinatorial Materials Manufacturing and Testing Engineering	Possibilities of using DED laser additive techniques for combinatorial search for new engineering materials. As part of the course, attempts will be made to synthesize both continuous and discrete alloy libraries and the possibility of their rapid study.
32.	Reactive mechanical grinding as a method for the synthesis of modern hydrogen storage materials in the solid phase.	Synthesis of solid-phase hydrogen storage materials using reactive hydrogen grinding in ball mills. Attempts at the synthesis of selected metal hydrides and complex hydrides and studies of the influence of synthesis conditions on its result and the properties of the produced material.
33.	Additive techniques with elements of reverse engineering	Devices used in reverse engineering. Editing and processing of point clouds and generation of STL files, taking into account technological specifics. Preparation for 3D printing (model positioning, material selection, degree of infill, division into layers, source code generation). Multi-variant production of models with complex geometry using FDM and SLA techniques. "Post-processing" and assessment of the quality of the obtained printouts using a 3D scanner and a micro-computed tomography.
34.	Overview of additive techniques used in	The idea, technical solutions and development trends of 3D printing. Overview of additive methods used in strategic industries – material, technological and

Lp.	Item Name	Curriculum content
	modern technology	economic conditions. Specifics of the processing of high-strength thermoplastics used in aviation and medicine – devices, technological parameters of 3D printing. Evaluation of the geometric and metallurgical quality of sample parts of printed machines using various additive techniques. Additive technologies and Industry 4.0.
35.	Selected issues in 3D printing	Analysis of the possibility of manufacturing structural elements using Rapid Manufacturing techniques. Specificity of processing advanced construction materials using laser additive forming methods. Material tests and assessment of geometric quality of printouts. Traditional vs. laser methods of regeneration of machine and equipment parts. Analysis of the possibility of reconstructing the operating indicators of machine and equipment parts using the semi-industrial LENS system – multi-criteria quality assessment.
36.	Researcher's workshop 1 – tools for writing scientific texts	The course introduces the doctoral student to issues related to the basic methods of creating texts describing the results of research work, including advanced use of the functions of the following programs: MS Word, LATEX, ENDNOTE, MENDELEY and practical ways of creating drawings, tables and citations. In addition, doctoral students are familiarized with the methodology of selecting the right journal and practical tips when sending manuscripts for publication in prestigious journals.
37.	Researcher's workshop 2 – writing scientific articles	The course introduces the doctoral student to issues related to the basic methods of designing the content of scientific articles, the vocabulary used, methods of graphic processing of results and the use of software helpful in the creation of scientific texts. In addition, the methods of literature analysis, the ethics of creating scientific texts and the selection of author's typesetting, the basis of the methodology for processing results, as well as the possibilities of using software and services for linguistically correcting scientific texts will be presented.
38.	Researcher's Workshop 3 – Writing Scientific Articles	The subject introduces the doctoral student to issues related to the estimation of measurement uncertainty in scientific papers. The issues raised during the classes are focused on learning practical methods of determining uncertainty in real measurements. Theoretical aspects, i.e. the mathematical apparatus used in estimating uncertainty, is reduced to the necessary minimum. Part of the classes is intended to solve the issues reported by doctoral students.
39.	Quantum mechanics in examples	The course aims to solve in detail and analyze the most important examples describing the behavior of particles in the microworld in the language of quantum mechanics. After the introduction to wave mechanics, the following examples will be analyzed: free particle; transmission (reflection) through the potential threshold; transmission (reflection) through the potential barrier (tunnel effect); an infinite pit of potential; a finite pit of potential; harmonic oscillator; the Krönig-Penney model; solving the problem of the Coulomb potential.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

Lp.	Item Name	Curriculum content
1.	Numerical Analyses in Load-Bearing Structures	Theoretical foundations of numerical methods of analysis of load-bearing structures including multi-stage analyses, strategy of computer FEM simulation of two- and three-dimensional problems in the field of mechanics and strength of materials and methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphics preprocessors. Construction of 2D and 3D models for analysis in the field of selected engineering issues, performance of calculations with attention to the selection of optimal analysis parameters and assessment of the correctness of calculation results using analytical methods and available results of experimental tests, on the example of elements and components of vehicles, special and load-bearing structures.
2.	Autonomy of mobile robots	Introduction, definitions, components of the construction of mobile robots. Wheeled robot drive systems. Navigation and self-location of robots. Navigation with the use of markers. Odometry, methods to improve self-localization results. Determining the position of the robot based on the map. Methods of planning the path of a mobile robot. Local planning, probabilistic methods. Tasks, construction, architecture of control systems Vision systems in mobile robotics. Walking robots. Applications of autonomous mobile robots.
3.	Non-destructive testing of aircraft	Types of defects, defects and damage that threaten the safety of operation of technical facilities. Non-destructive testing methods – physical basis. Visual and penetrative methods. Ultrasound method. Acoustic methods. Eddy current method. Thermographic method. X-ray method. Shearograps and DSight. Non-destructive testing methods – advantages, disadvantages and limitations in use. Non-destructive testing certification.
4.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of the human body model and experimental research. Calculating the risk of injury to the head, torso and thighs. Injury risk prediction models.
5.	Construction and operation of industrial robots	Construction and operation principle of industrial robots. Principles of robotization of production lines. Environments and languages for programming industrial robots
6.	Digital signal processing	Mathematical models of deterministic signals. Advanced signal sampling techniques. Selected problems of analysis of discrete signals in the time and frequency domain. Frequency resolution of digital spectral analysis algorithms. Fast weave algorithm. Selected specialized implementations of digital filters. Basics of digital filter design. Decimation and interpolation of digital signals. Digital signal spectrum conversion. Direct Digital Signal Generation Method (DDS). Program receiver.
7.	Design of experiment	Determined and randomized experiment plans. Measures of position and dispersion of measurement results. Assessment of the significance of the impact of input quantities on the output quantity. Specify a function that approximates the function of an object. Assessment of the adequacy of the function of the facility and the significance of its coefficients. Experiential optimization.
8.	Dynamics of mechatronic system design	Issues of modeling mechatronic systems. Elements of motion and vibration analysis of linear systems with single and multiple degrees of freedom. Elements of motion analysis of nonlinear mechatronic systems. Stability testing of linear and nonlinear mechatronic systems. Self-excited vibrations. Methods of measuring vibrations of mechatronic systems.
9.	Dynamics of car movement	Modeling the movement of the car. Modeling of movement on hard, snowy and deformable surfaces. Analysis of the dynamics of rectilinear and curvilinear motion. Steerability and stability. Overcoming terrain obstacles. Wheeled and tracked chassis. Modeling the process of a car crashing into an obstacle. Analysis of vibrations and driving comfort.
10.	Dynamics and modeling of hydrostatic	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis

Lp.	Item Name	Curriculum content
	systems	and its description. Modeling of hydrostatic drive assemblies, subassemblies, elements and systems. Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
11.	Dynamics of multi-member systems	Theoretical foundations of numerical methods of analysis with the use of rigid bodies and the strategy of computer simulation of multibodies with the use of various algorithms for the formulation of equations of motion and their integration. Overview of multibody analysis software environments and examples of mechanical engineering solutions. Methods of modeling mechanical structures with rigid solids in planar and spatial systems. Construction of planar and spatial models with the use of various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected issues of mechanical engineering. Multivariant numerical analyses with attention to the selection of optimal calculation parameters and the assessment of the correctness of the obtained results using analytical and experimental methods.
12.	Solid collision dynamics	Equations of the dynamics of solid collision. Collision energy balance. Deformation and restitution. Modeling of post-collision motion of solids that are subject to deformation in the area of their contact. Biomechanical models for the analysis of shock loads. Risk of injury caused by impact on the human body.
13.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
14.	Computer-aided operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
15.	Shaping a safe car body	Body construction - shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
16.	Composite materials in mechanical engineering	Definition and classification of composite materials. Strength and performance properties of composite materials. Technologies for the production of composite materials. Research used in the experimental analysis of mechanical properties of composites. Joining composite materials. Metal-composite joints. Exploitation of composite materials. Repairs of composite structures.
17.	Finite Element Method	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
18.	Methods of analysis of numerical experimental research results	Selected deterministic and stochastic examples in the research methodology allowing the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
19.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
20.	Experimental methods for investigating the thermophysical properties of solids	Thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
21.	Methods and techniques for testing	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of

Lp.	Item Name	Curriculum content
	the mechanical properties of materials	elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring deformations during strength tests. Methods of testing the mechanical properties of materials under shock loading conditions. (Hopkinson test, Taylor test, ring test).
22.	Numerical Methods in Engineering Applications	Basic concepts related to numerical calculations, sources of errors. Interpolation and approximation. Differentiation and quadrature. Systems of linear equations. Algebraic eigenproblem. Methods of solving ordinary differential equations. The linear problem of least squares. Fourier analysis. Optimization elements. Information about other areas of numerical analysis (partial differential equations, stochastic methods, etc.).
23.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
24.	Methods for designing and optimizing aircraft structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission modeling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
25.	Constitutive Models of Materials in FEM Analysis	Mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. Experimental studies to determine the parameters of models. Numerical analyses using learned material models.
26.	Modelling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software
27.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
28.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
29.	Parametric modeling and structural optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
30.	Flow modeling	Methods of computer modeling of flow processes in basic and applied problems of fluid motion dynamics. Simulation methods for researching streamlined issues. Basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver. Modeling of flow turbulence, including averaged Navier-Stokes equations, turbulent stress tensor, turbulence modeling capabilities and problems. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES). Mapping of complex simulation study objects, construction and execution of basic operations on computational grids, analysis of the reliability and accuracy of numerical modeling results.
31.	Modeling machine	General principles of modeling of hydrostatic, electromechanical systems. Deterministic and random processes. Construction of simulation models.

Lp.	Item Name	Curriculum content
	motion	Identification of model parameters and their validation. Characteristics of basic dynamic members. Basics of dynamics of systems with variable mass.
32.	Modeling composite structures	The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.
33.	Modeling of the Contact Phenomenon in Structural Mechanics	General division of contact phenomena. Mathematical foundations of the description and solution of the problem of contact. Algorithms for defining and solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
34.	Modeling and research of the processes of cooperation between the wheel and the road	Issues of modeling and testing the processes of cooperation between the wheel and the road to the extent necessary to model the dynamics of vehicle motion (selected mathematical models, methods and techniques of testing tire wheels on a drum stand and with the use of a test trailer).
35.	Modeling of car traffic and controls	Review of vehicle motion dynamics models and models describing the driver-vehicle-road system (models of lateral dynamics of the car in various control configurations).
36.	Modern technologies for bonding structural materials	Friction stir welding (FSW), laser beam welding (LBW), areas of application and strength properties of the cohesive joints obtained. Influence of bonding processes on the microstructure of selected construction materials. Heat and mechanical treatment of FSW and LBW cohesive joints.
37.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
38.	Renewable energy sources	The importance of energy in the development of modern civilization. Modern fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
39.	CAE Engineering Software	An overview of CAE engineering support systems with an indication of their purpose and the possibility of using them in structural analyses. Preparation of numerical models for calculations in the static and dynamic range. Running calculations and presenting and processing the results obtained.
40.	Experiment planning and optimization of mechanical objects	Optimize your experiment using experiment plans and statistical models. Factor plans. Optimization plans. Determined plans. Plans to be analyzed, composition – property. Analysis of the relevance and adequacy of statistical models. Methods of determining the extremum of statistical functions. Examples of the use of experiment optimization in mechanical engineering.
41.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Statistics of road accidents and their interpretation.
42.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
43.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.
44.	Fundamentals of Mechanics of	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.

Lp.	Item Name	Curriculum content
	Continuous Media	
45.	LabVIEW Basics	Hardware and software from NI. The process of creating an application in LABVIEW. Data Types in LABVIEW, Complex Data Types in LABVIEW, Communication with Measurement Devices in LABVIEW.
46.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.
47.	Programming of control systems for unmanned working machines and robots	Introduction to the UML standard. Build relational schemas and use case schemas. Creation of control algorithms. Introduction to programming, programming devices for hydrotronic applications. Design a feedback loop. Implementation of feedback loops in control systems.
48.	Mechatronic sensors	Mathematical models of mechatronic sensors. General principles of mechatronic sensors. Methods of measurement, errors and methods of calibration of sensors.
49.	Condition monitoring systems	Sensors used in condition monitoring. Resistance strain gauge. Fiber optic sensors. Crack sensors. Data transmission. Recording and analysis of measurement data. Inference. Coupling of condition monitoring systems with the operating system and the operation system.
50.	Aircraft Operation Systems	Principles of operation and repair of military aircraft in the Republic of Poland. Harmonized European Military Airworthiness Regulations (EMAR). European Airworthiness Regulations (PART). The role of EASA and the Civil Aviation Authority in supervising the operation of aircraft. Bulletins and other documents regulating the operation.
51.	Control systems in mechanical engineering	Advanced control systems for mobile machines. Machine control system functions. Types of control systems. Development trends of sensors used in mobile machines. Vision and lidar locating and navigation systems. Satellite systems in machine control Centralized and distributed control. Intelligent communication networks. PLC control. Fuzzy logic in machine control
52.	Technologies for the production and processing of composite materials	Composites, ways of defining them, types of components that make them up, the most important methods of their production and processing, the importance of this class of materials in mechanical engineering. The structure of modern composite materials depending on the method of production and the treatment used, e.g. heat, thermo-plastic. Manufacture of ceramic matrix composites and multilayer metallic composites and achievements in the use of composites.
53.	Selected solutions in the field of automotive technology and car motion	Problems of the development of automotive technology and road traffic. Concepts of intelligent transport systems. Selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs, lighting systems). Driver assistance systems. Self-driving cars.
54.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
55.	Thermomechanics of materials and studies of thermophysical properties	Phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and presentation of selected issues of statistical description of these phenomena to explain the nature of thermo-physical properties. Heat transfer phenomena in materials and material structures. Material properties vs. resultant and apparent properties of material structures. Methodology of testing thermo-physical properties. Thermal Analysis Methods. Methods for determining specific heat, thermal conductivity, thermal diffusivity, thermal expansion of materials and material structures.
56.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.

Lp.	Item Name	Curriculum content
57.	Durability of aircraft structures	Methods for determining and testing aircraft durability. Concepts of aircraft operation, factors limiting the durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in aircraft operation. Corrosion of aircraft.
58.	Introduction to the equations of mathematical physics	Formulation of mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. General principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics. The method of reducing borderline issues to a dimensionless form is discussed. Formulation of mathematical models based on mathematical physics equations.
59.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
60.	Modern test methods for internal combustion engines and vehicles	Identification of the purpose of research. Selection of the test method. Validation of research methods and procedures. Approval test procedure. Selected methods of homologation tests, measuring equipment. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty Analysis and presentation of research results. Calibration of measurement systems. Practical implementation of selected research methods.
61.	Selected methods and techniques of temperature measurement	Theoretical basics of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. Types of thermometers: liquid, thermoelectric, resistive, thermistor, quartz, bimetallic, radiation, fiber optic and thermal imaging cameras. Statistical processing of measurement results
62.	Selected problems of rocket technology	Mathematical models of physical processes related to the dynamics of rocket motion. General rules for building rockets. Construction of rocket compartments with mathematical models. Computer simulation and visualization of the rocket flight path. Overloading of rockets on the flight path.
63.	Selected issues of waste gas treatment from motor vehicles	The impact of the automotive industry is influenced by the natural environment. Characterization of harmful substances. Systems and methods of motor vehicle waste gas treatment. Development tendencies in flue gas cleaning methods. Test methods and equipment for testing waste gases from internal combustion engines and vehicles. Studies on the influence of the operating condition of an internal combustion engine on the emissions of individual exhaust components and the granulometric composition of particulate matter.
64.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	Simulation tasks. Selection of the simulation method. Selected models of the work cycle of an internal combustion engine. Workflow simulation software. Procedure for simulating selected routings. Analysis and presentation of simulation results. Evaluation of simulation results. Simulation of selected working processes of internal combustion engines.
65.	Selected issues of object-oriented programming	Introduction to the object-oriented programming paradigm. Intermediate code and runtime issues. Introduction to C# and Microsoft Visual Studio. Create console programs using C# and Microsoft Visual Studio. Introduction to Python. Creating programs based on selected algorithms.
66.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Application of the principles of fatigue strength of materials and fracture mechanics. Fatigue test methodologies and fatigue testing equipment. Crack development due to cyclic loads. Fatigue crack growth characteristics. Methods for evaluating the strength of cracked components
67.	Advanced methods of manufacturing products from sintered powders	Manufacturing processes of machine parts using modern methods of manufacturing engineering, including powder metallurgy.
68.	Advanced ballistics, modeling, and simulation	Development trends in the field of solid propellants and propellant systems (theoretical basis for modeling the operation of atypical propellant systems from the point of view of internal ballistics). Outflow of powder gases from the barrel during firing and their flow through the muzzle brake (description of the

Lp.	Item Name	Curriculum content
		phenomena occurring during the outflow of gunpowder gases from the barrel during firing - transitional ballistics). Geometrical, mass-inertial and aerodynamic characteristics of missiles and rockets (theoretical basis for modeling the motion of flying objects from the point of view of external ballistics). Modeling of the impact impact of objects (theoretical foundations for analytical and numerical modeling of phenomena that are the domain of final ballistics).
69.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
70.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
71.	Advanced measurement systems	Structure and organization of computer-controlled measurement systems and with procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. Programming basics and how to use virtual instruments to collect, collect and process measurement data.
72.	Advanced Materials Testing Methods	Methods of testing materials, possibilities and limitations of various test methods based on the use of specialized equipment. Modern electron microscopy, confocal microscopy and X-ray microanalysis (qualitative and quantitative) and their practical application in mechanical engineering. Methods for investigating the macro- and microstructure of metals, their alloys and ceramic materials, and interpreting the test results obtained by various materials testing methods. Topographic contrast and its use for fractography studies, evaluation of changes in the microstructure of materials as a result of treatments, studies of powders and thin surface films. Microanalysis of phases and inclusions in materials research. Testing of material heterogeneity. Trace analysis of elements. Light microscopy in materials research. Metallography. Image analysis. Electron beam and its properties. Electron diffraction. Structure of a scanning and transmission electron microscope.
73.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
74.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
75.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	Issues related to wave propagation (elastic, plastic). Mathematical description of the phenomenon of mechanical wave propagation. Boundary conditions. Methods to solve the presented issue. Numerical analysis of wave propagation.
76.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force. Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
77.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials. Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.

Lp.	Item Name	Curriculum content
78.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations - condition index. Gaussian method of numerical solving of a system of linear equations. Direct methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Methods of numerical solving of ordinary differential equations.
79.	Electromagnetic field theory	Maxwell's equations; Differential form of Maxwell's equations in material media; Maxwell's equations for harmonically variable fields; Integral form of Maxwell's equations. Electromagnetic waves in an ideal dielectric; TEM type flat wave; Wave impedance and specific impedance. Electromagnetic waves in a lossy medium. Boundary conditions and energy relationships in the electromagnetic field. Power balance in the electromagnetic field in real and complex description. A real, complex and time-average Poynting vector. Wave incident obliquely on the dielectric-dielectric interface; Fresnel formulas for a plane wave falling obliquely on the boundary of two dielectric media. Reflectivity and power transmission. A wave incident perpendicularly at the dielectric-dielectric interface. Determination of reflection coefficients and power transmission for a plane wave incident perpendicularly on the boundary of two dielectric media. Electromagnetic waves in waveguides. Wave Mods. Potentials in electrodynamics and radiation from current sources; Vector and scalar potential. Delayed electromagnetic potentials. Potentials generated by localized sources. Hertz's Dipole.
80.	Quantum mechanics	Wave function and Schrödinger equation. Probabilistic interpretation of the wave function. Probability current density. Expected value. Separation of the wave equation. Quantum Mechanics Formalism; N-dimensional vector space; Space base; Scalar product; Hilbert space; Orthogonality of vectors and systems. Orthonormal bases; Linear operators; Operator equations; Matrix representation of an operator; Hermitian and unitary operators; Dirac notation. Selected solutions of the Schrödinger equation in 1D; A quantum particle in an infinite potential well. A free quantum particle. Uncertainty of Observables - Heisenberg Uncertainty Principles. Eigenvalues and eigenfunctions of a quantum harmonic oscillator. Creation and annihilation operators. Separation of the Schrödinger equation in 3D. Quantum particle in a spherical potential well in 3D. Values and eigenfunctions of the angular momentum operator. The spin theory of the electron. - Pauli matrices. Mutual uncertainty of spin components. Entangled states and non-locality. - The concept of entangled states and qubit. Their role in new quantum technologies.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

Lp.	Item Name	Curriculum content
1.	Analysis of Chemical Warfare Agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and technology of liquid crystal materials	Molecular structure, structures and textures of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and technology of high-energy materials	Current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels: structural determinants of the stability and sensitivity of explosive compounds; design, fabrication and characterization of nanostructured explosive mixtures; principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; New ways to craft explosive compositions and form them into charges. design, manufacture and characterization of thermobaric explosives; design, synthesis and explosive properties of complex compounds; design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids as well as new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Chemical Foundations of Environmental Pollution	Basics of ecology. Man and the environment. Natural resources and ecological factors: temperature, radiation, air, water and soil. Humanity in the face of global challenges. The paradigm of sustainable development. Principles of green chemistry. Air pollution (acid jet, ozone depletion, greenhouse effect, London and Los Angeles smog). Sources of water pollution (municipal, industrial and agricultural pollution). The most important pollutants found in sewage. Pollution of seawater. Water treatment. Soil pollution. Types of harmful effects of human activity on soil: geomechanical, hydrological and chemical transformations, physical and biological degradation. Heavy metals, their characteristics, sources and impact on the environment and human health. Characteristics of cleaning and washing agents (soaps, detergents). Negative effects of using cleaning and washing agents. Organochlorine compounds in the environment (chlorophenols, polychlorinated biphenyls, dioxins). Pesticides. Classification of pesticides and their properties. Chemical structure of pesticides. Pesticide forms. Benefits and problems of pesticide use. Building materials (paints, adhesives, asbestos, products containing formaldehyde, oils) and their impact on the environment and human health. Volatile organic compounds (VOCs). VOC sources. Harmful effects of VOCs in the stratosphere. Pharmaceuticals and personal protective equipment in water. Classification, sources of origin, occurrence and environmental impact of drug residues. Food chemistry. Classification and characteristics of food additives (preservatives, improvers, antioxidants, flavor enhancers, sweeteners, dyes). Dietary supplements.
5.	Physics and chemistry of carbon materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and bioactivity of carbon materials. Prospects for the development of new carbon

Lp.	Item Name	Curriculum content
		structures and their applications.
6.	Physicochemical aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
7.	History of chemistry	Synthesis of elements in the universe, first observations and chemical achievements of antiquity (alchemy). History of chemical discoveries in the world: physical chemistry, analytical, chemical analysis, organic synthesis, food chemistry. Achievements of chemistry after 1661 (R. Boyl). Development of separation techniques and analysis and their impact on the development of views on chemistry and the structure of chemical compounds. Evolution of nomenclature and symbols of elements and chemical compounds. History of the periodic table, kinetic and thermodynamic studies. The development of chemistry and organic synthesis in the twentieth century and its impact on the emergence of molecular biology.
8.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
9.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
10.	Spectroscopic methods	Expanding the knowledge on spectroscopic methods for PhD students in the discipline of chemical sciences. Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Modern spectroscopic methods.
11.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Adsorption of nitrogen and argon as a complete method for determining the specific surface area, porosity and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and investigation of adsorption properties of graphene composite materials. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
12.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials

Lp.	Item Name	Curriculum content
13.	Signal Processing in Analytical Chemistry	Basic methods of processing the analytical signal. Spectra obtained from measuring instruments used in analytics. Big data processing. Multivariate data obtained from combined measurement techniques. Search for analytical information contained in large data sets. Elements of chemometrics. Principal components method. Similarity analysis. Presentation of measurement data in scientific publications.
14.	Synthesis of liquid crystals	Introduction to liquid crystals, structure and anisotropic properties. Applications of liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Super fluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
15.	Introduction to Spectroscopy	Basic knowledge of spectroscopic methods for PhDs in disciplines other than chemical sciences. Two versions of the item are possible. Standard version: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Individual version in accordance with the interests of the PhD student, extending selected spectroscopic methods from the given group of methods: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). Oscillation-rotational and rotational spectroscopy. One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Circular dichroism spectroscopy (ECD and VCD). Mass spectrometry (MS).
16.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
17.	Advanced pyrotechnics	The latest solutions used in military and civilian pyrotechnics. Currently used reducers, oxidants, binders and modifiers. Pyrotechnic applications of high-nitrogen compounds. Modern compositions of curtain smokes active in the infrared range. Modern multi-base solid rocket fuels. Solutions used in airbag inflators. Prospective applications of pyrotechnic mixtures in medicine. Basic algorithms used in modeling combustion processes and analytical optimization of the composition of pyrotechnic compositions.
18.	The use of gas chromatography in research Physicochemical	The essence of interactions in chromatography. Mechanisms of chromatographing test substances. Basic chromatographic quantities. State functions – methods of calculation and interpretation. Study of the physical transformations of pure substances. Phase stability and phase transitions. Study of surface properties and basic surface phenomena. Methods of surface determination and analysis.
19.	Polymer chemistry	Polymers obtained in the process of polychain reaction. Condensation polymers, polyadducts. Inorganic-organic polymers. Polymers of natural origin. Special-purpose polymers.
20.	Modeling and simulation computer programs in chemistry	Fundamentals of Computational Chemistry: Computational Assumptions and Methods. CHEMCAD program organization and basics of use. Application of CHEMCAD in chemical technology and materials engineering. Implementation of a project in the field of chemical technology using the CHEMCAD system. Organization of the SCIGRESS program and basics of use. Optimization of geometry and calculation of physicochemical properties of molecules. Modeling of chemical reactions in the gas phase and solution. Modeling of spectroscopic properties of molecules.

Annex VI.7

to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security sciences

No.	Item Name	Curriculum content
1.	Social research in the sciences Safety	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Non-reactive methods. Desk *research*
2.	Statistical methods in research Social	Population and sample. Statistical features. Measurement scales. Random variables. Normal distribution. Characteristics of qualitative and quantitative characteristics. Nonparametric estimation. Parametric estimation (point and interval). Verification of statistical hypotheses. Diagram of the materiality test. Testing the normality of the distribution. Problems of analysis of the interdependence of phenomena. The research process in the social sciences and the typical structure of scientific work. The course of data collection, analysis and evaluation.
3.	Risk management in security	Risk concept and risk management process. The concept of risk and risk management. Development of the risk management field. Risk management process. Risk measures. Types of risk in the security sector. Risk measurement in public sector entities. Risk measurement in the context of ensuring system continuity.
4.	Management system designs Security	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
5.	Safety Systems Engineering	The place of systems security theory in the family of sciences. Basic concepts of system security (system status, description of system security-related states, system security indicators). Principles of mathematical modeling of system security. Component and subsystem safety. Systems security models. Systems security research. Analysis of system security. Control of safety, systems.
6.	Propedeutyka Security	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies are the "old" and "new" wars in the interpretations of realism and constructivism.
7.	Management strategies and concepts Security state	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal functional factors and ways of defining security in doctrines and strategies (comparative analysis).
8.	Management Crisis in administration Public	Contemporary concepts of crisis management (the concept of vulnerability, the concept of resilience, the concept of adaptation). The subject of crisis management. Legal basis of crisis management in Poland. Crisis management process. Basic types of threats – sources of crisis situations. A crisis situation. Crisis management system in Poland. Effectiveness in crisis management.
9.	Safety Common	The essence of public safety. General security and national security. Mechanisms shaping public safety. Rescue. Civil protection. Civil Defense. Fire protection. Critical infrastructure protection. Organization of the protection of human life and health, material and cultural goods and the natural environment Methods and tools used to ensure public security in Poland and the EU.
10.	Safety Internal	Perception of security. Political determinants of internal security. Institutional system of internal security. Administrative police in the internal security system. Private entities in the organization of internal security. Organization of security in the region. Organization of security in the district. Organization of security in the district.
11.	Data analysis Survey	Creating measurement tools. Sampling. Preliminary analysis. Schedule analysis. Contingency tables, boundary and conditional distributions. Analysis of single-choice and multiple-choice questions. Significance and strength of the relationship between nominal and ordinal variables. Hypothesis testing.
12.	Analysis Multidimensional	Methods of graphical presentation of multidimensional data. Multiple regression analysis. Analysis of canonical correlations. Principal components analysis. Exploratory Factor Analysis (EFA). Multidimensional scaling. Linear ordering. Cluster analysis.

No.	Item Name	Curriculum content
13.	Test procedures Evaluation	The concept of evaluation research. History and institutionalization of evaluation research. Types of evaluation research – the concepts of "impact assessment", "action research". Differentiation of evaluation research in terms of their social functions. Experimental designs in evaluation studies. The Concept of Experimental Society by A. Etioni. Monitoring and evaluation. Elements of cost-benefit analysis in evaluation research. Measurement problems in evaluation research.
14.	The theory is logical Argument	Logical argumentation. Deductive, reductive and inductive inferences. Diagrams and argumentation diagrams. Recognizing arguments. Diagram. Classified premises and conclusions. Elements of the evaluation of argumentation. Acceptability of premises. Reliability of sources. Relevance.
15.	Forecasting and simulations in security	Forecasting and social practice. Social premises for predicting behavior. Forecast vs. decision-making. Model methods. Extrapolation of trends. Validity, admissibility and error of the forecast. Forecasting based on time series. Forecasting based on econometric models. Heuristic forecasting models. Social simulations.
16.	Modern technology in security	Know-how, modern technologies and their importance in ensuring safety. Modern technologies in the defense and protection system. Modern technologies in the economic security system of the state. Modern technologies in the social security system. The use of modern safety technologies in electricity generation, in the transport system, in the protection of critical infrastructure, in the protection of the natural environment.
17.	Philosophy of Sciences Safety	Origins, subject and branches of philosophy and philosophy of security as the most general knowledge about security. The genesis and types of human knowledge in philosophical discourse (sources: mystical, intuitive, philosophical and scientific; types: scientific, theoretical, practical and intuitive). The logic of scientific discovery, revolution in science and the progress of knowledge in the view of contemporary epistemology. Semantic analytics of the name security and types of its understanding – the essence of security in philosophical terms. A natural and conventional concept of security. Materialistic, idealistic and realistic concepts in the hermeneutic anchoring of security. The Praxeological Concept of the Four Simple Acts and Universal Methods of Shaping Security. Tendencies in Broadening, Deepening and Thickening Security Studies The Method of War, Peace, Non-Peace and Non-War in Praxeological Approach. Philosophical problems of security in contemporary societies of control and surveillance from the perspective of dataism and technohumanism.
18.	Modern terrorism	Basic concepts and their meaning. The origins of terrorism. Causes of modern terrorism. The main factors generating and escalating terrorism. Systematization of the causes of terrorism. A triad of terrorist motivation. Key elements and types of terrorist threat. The scope and nature of terrorism at the beginning of the 21st century. Effects of terrorism. Preventing and combating terrorism.
19.	Morals and culture Security in relationships National and international	The essence and importance of the security culture (KB) and morale (M) of physical and legal entities in internal and international relations. Psychosocial and praxeological models and "mechanisms" of KB and M functioning – relations between them. Safety culture (KB) and morale as types of key resources and competitive advantage factors in "normal" and crisis situations. Security culture as an interface integrating the security areas in question and the national security system (SBN). Intuitive and scientific ways of diagnosing and improving KB and M. Security culture and morale in times of information warfare and asymmetric conflicts
20.	History Security	Military, political and economic security of medieval Polish and the Polish-Lithuanian Commonwealth until its collapse. The main problems of European security in the nineteenth century. Polish national uprisings of the nineteenth century. World War I. Determinants of international security in the interwar period. Military, political, economic and social security of the Republic of Poland (1918–1939). World War II. International security in the second half of the twentieth century. U.S.-USSR relations and their impact on international security. Military, political and economic security of Poland after World War II.
21.	Communication Strategy	Characteristics of strategic communication (terminology, essence, responsibility in NATO). Public diplomacy (terminology, essence, structures). Informing the public (terminology, essence, structures). Information operations (methods, views of NATO, views and structures of the USA, Polish views). Psychological operations (methods and techniques of action, US structures, German structures, Polish structures, British structures).

No.	Item Name	Curriculum content
22.	Political sector Security	Political security. Concepts. Political security in security sciences. Forms and types of political threats as well as determinants and research of political security. A model of institutionalization of political security. The need for citizen security and the tasks of a democratic state. The crisis of civic identity. Power as a factor of security. Security strategy as an instrument of political security. The influence of interest groups on political decisions. Media – shaping public opinion. The basic dilemma of political security.
23.	Shaping Security Military in the 21st century	Characteristics of military security of selected states and associations of states in relation to the methodology of identification and description of challenges, and thus potential opportunities and threats to the existence and development of individual societies. The terminology of military security, the components of this security, the impact of these elements on the state and process of military security in the face of identified and described challenges (opportunities and threats) in the perspective of the current century.
24.	Safety Information	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPauduli, Biby, Shiver-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
25.	The economic dimension of safety	Defining economic security and its dimensions. Economization of state security. Typology of threats to economic security. The state and the national economy in the face of contemporary cultural and civilizational changes. Economic aggression in international relations. Financial crises. Activities of transnational corporations. Technological espionage as a threat to economic security. State activity to ensure economic security.
26.	Safety Energy facing Transformation socio-economic	The impact of socio-economic transformation on the functioning of the energy sector of developing and developed countries, and thus also on the energy security of these countries. A parallel process of influencing the way the energy industry operates, as well as the functioning of the energy security sector to protect the industry against threats (both old and new, generated by current socio-economic changes).
27.	Social Conditions Security modern states	The essence of social security. Social security and the model of the state system. Mechanisms shaping social security. Concepts of social security. Models of social security in the EU. Problems of social security in Poland and ways to overcome them. EU activities for social security.
28.	Combating and corruption prevention	Seminar classes. Threats to state security caused by corruption behaviors. Forms of corruption and the offences associated with them. Legislative activities and services responsible for combating and reducing corruption and the principles of building effective anti-corruption solutions in public organizations and in the private sector.
29.	Operational methods of combating serious criminal crime	Seminar classes. Statutory operational methods, i.e. operational control, covertly supervised shipment, controlled purchase and controlled giving/acceptance of financial benefits, used to combat and prevent serious criminal crime. The rules for granting consent to the use of the indicated tools for combating this type of crime and the use of evidence obtained in this way in criminal proceedings. Methods of controlling the use of such non-procedural measures to ensure state security.
30.	Safety Organic on a global scale regional and national	Types of challenges (opportunities and threats) generated by climate change in the area of environmental security. Identification of the impact of climate change on the national security of selected societies on a national, regional and global scale.
31.	Cultural security factors	Culture: concept, categories, identity. Cultural security: conceptual aspects, cultural security in the area of spiritual culture, security in the area of material culture. Cultural threats to the security of the Republic of Poland. The cultural security system of the Republic of Poland. Cultural aspects of international relations. The Cultural Background of International Conflicts. Security Culture – National and International Aspects

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology

No. 27/WAT/2023 of 23 February 2023

amending the resolution on the establishment of the "Curriculum of education at the Doctoral School of the Military University of Technology"

Pursuant to § 21(1)(21) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is hereby resolved:

§ 1

The following changes are made to the Curriculum of the Doctoral School of the Military University of Technology, which is an annex to the Resolution of the Senate of the Military University of Technology No. 10/WAT/2022 of 24 February 2022 on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology":

1) the words *'automation, electronics and electrical engineering'* are replaced by the words *'automation, electronics, electrical engineering and space technologies'*;
2) the words "civil engineering and transport" shall be replaced by the words *"civil engineering, surveying and transport".*

§ 2

The resolution enters into force on the day of its adoption, with effect from 11 November 2022.

President of the Senate

/--/ Brig. Gen. Prof. Przemysław Wachulak

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 23/WAT/2023 of 23 February 2023

on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology" - 2023 edition

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended), in connection with § 21(1)(21) of the Statute of the Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is resolved:

§ 1

The "Education program at the Doctoral School of the Military University of Technology" *is hereby established,* constituting an attachment to the resolution.

§ 2

The curriculum referred to in § 1 is in force from the academic year 2023/2024.

§ 3

Doctoral students of the Doctoral School of the Military University of Technology who started their education before the academic year 2023/2024 may update their Individual Education Programmes on the basis of this programme.

§ 4

The resolution shall enter into force on the date of its adoption.

President of the Senate

Brig. Gen. Prof. Przemysław Wachulak, PhD, DSc, Eng.

Attachment to the Resolution of the Senate of the Military University of Technology No. 23/WAT/2023 of 23 February 2023

CURRICULUM

AT THE DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

- EDITION 2023

I. General principles

1. The curriculum at the Doctoral School of Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics, electrical engineering and space technologies** - a field of engineering and technical sciences;
    2) **technical informatics and telecommunications** - a field of engineering and technical sciences;
    3) **civil engineering, geodesy and transport** - a field of engineering and technical sciences;
    4) **materials engineering** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security sciences** - a field of social sciences;
    7) **Chemical sciences** - a field of exact and natural sciences.
2. The learning outcomes take into account the requirements specified for the 8th level of the Polish Qualifications Framework.
3. Number of semesters: **8**
4. Number of ECTS credits – min. **30 points**
5. The number of compulsory courses is 100 hours and 20 hours of practical training carried out in the form of conducting classes or participating in them and corresponds to a total of 10 ECTS credits, and the number of optional courses is at least 200 hours and corresponds to at least 20 ECTS credits**.** Optional courses may include classes in subjects carried out at MUT from the optional module of at least 100 hours and 10 ECTS credits, courses carried out at another university or scientific institution in Poland or abroad, and other forms of education, e.g. apprenticeships, internships at and outside the Military University of Technology, in particular at another university or institution in Poland or abroad.
6. Language of conducting:
    a. **Polish or English –** only in the case of subjects, internships or other forms of education indicated in the Individual Education Programme (IPK),
    b. **English –** in the case of education in a scientific discipline in English.
7. The program is valid from: academic year **2023/2024.**
8. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:
   Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is the professional preparation of future staff in the fields of engineering and technology, exact and natural sciences and social sciences, in particular in the field of military technology and security technology. The task of the Doctoral School is to provide doctoral students with the latest knowledge, shape skills and improve competences at the highest level, as well as cultivate patriotic

traditions and responsibility for the Homeland in broadly understood aspects, both military and civilian, in accordance with the principle "Omnia Pro Patria" – "Everything for the Homeland". The activities of the Doctoral School correlate with the strategic objectives of the Academy's development in terms of strengthening the position of the Military University of Technology in the system of Polish and European higher education, including as the leading educational pillar of higher military education and the expert and research base of the Ministry of National Defense, as well as other ministries. In addition, it emphasizes the elite nature of the Academy as a university conducting innovative didactic and scientific activities, also developing international cooperation in this field.

9. Prerequisites for the candidate for the Doctoral School

   The candidate should have a Level 7 qualification. Polish Qualifications Framework (Master's degree, Master's degree or equivalent) and complete a Master's degree in a field related to the scientific discipline conducted at the Doctoral School or have scientific achievements in this discipline. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may admit a person who is a graduate of first-cycle studies or a student who has completed the third year of uniform master's degree studies. Detailed requirements are set out in the rules of recruitment to the Doctoral School established annually by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for subjects for which the university learning outcomes are required;
2) in the description *component code* column - reference of the assumed learning outcome to the appropriate code of the description component of the first- and second-cycle learning outcomes at level 8 of the Polish Qualifications Framework (PQF 8).

Effect number symbols	**Expected learning outcomes**	**code description component**

Effect number symbols	Expected learning outcomes	code description component
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_W P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
Skills: the graduate is able to		
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8U_U P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8U_U P8S_UW*
D_U03	*independently plan and act for their own development and inspire and organize the development of others,*	*P8U_U P8S_UU*
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks , in particular: − define the purpose and object of scientific research, formulate a research hypothesis, − develop research methods, techniques and tools and apply them creatively, − draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8U_U P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8U_U P8S_UK*
D_U10	*participate in scientific discourse, exchange of experiences and ideas, also in the international environment*	*P8U_U P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*

Effect number symbols	Expected learning outcomes	code description component
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*
D_U13	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*
	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_K* *P8U_KK*
D_K02	*taking into account the challenges in the professional and public sphere, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_K* *P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8U_K* *P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8U_U* *P8S_KK*
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8U_U* *P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8U_U* *P8S_KO*
D_K07	*initiating activities in the public interest*	*P8U_U* *P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8U_U* *P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including:* *− conducting scientific activity in an independent manner,* *− respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8U_U* *P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- completion of courses included in the Basic Module, including a doctoral seminar in the subject Analysis of the research area,
- credit for courses from the Optional Module of a discipline or scientific disciplines, professional practice and subjects carried out outside the Military University of Technology and other forms of education[1] included in the Individual Education Program (IPK),
- positively assessed by the supervisor of the doctoral dissertation.

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.

[1] if they appear in IPK

2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.
3. The curriculum includes at least 300 hours of classes[2] and at least 20 hours of professional internships in the form of conducting classes or participating in them - at least 30 ECTS credits in total.
4. The doctoral student's education program consists of:
   1) the basic module for doctoral students of all scientific disciplines conducted at the Doctoral School, 100 hours with a total of 9 ECTS credits;
   2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned, subject to sections 6, 7 and 8;
   3) 20 to 180 hours of practical training in the form of classes or participation in classes from the third to the seventh semester of education – max. 60 hours per year (in accordance with an individual curriculum), which are assigned 1 ECTS credit, regardless of the number of hours of practical training.
   4) optionally, courses taught outside the Military University of Technology and other forms of education on an hourly basis and the number of ECTS credits specified in an individual curriculum.
5. A doctoral student is required to complete the basic module and 20 hours of professional practice in the form of conducting classes or participating in them. A doctoral student, in consultation with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. It is allowed for courses to come from different scientific disciplines and to be taught at another university or research institution.
6. In the case of planned completion of courses outside MUT and other forms of education (e.g. internship, internship at and outside MUT), the supervisor determines the number of ECTS credits and the learning outcomes to be achieved, provided that the number of hours of courses taught at MUT from the optional module cannot be less than 100 hours and 10 ECTS credits.
7. In the case of education for foreigners in English, the subjects included in the basic module referred to in Chapter V, concerning the issues of Polish regulations, may be replaced by other subjects. Decisions on the introduction of new subjects are made by the Director of the Doctoral School in consultation with the Chairman of the Scientific Discipline Council, within which the education of foreigners is conducted.
8. The implementation of the education programme, taking into account the provisions of sections 5-7, should ensure that the candidate achieves the assumed learning outcomes specified in Chapter II.
9. By the end of the first semester of education, the doctoral student submits an individual education program to the director of the Doctoral School, agreed with the supervisor.
10. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year, subject to paragraph 11

[2] classes may include courses taught outside the Military University of Technology and other forms of education

11. Classes for foreigners providing education in English may be planned centrally or as part of a scientific discipline, taking into account the subjects referred to in paragraph 7.
12. Classes in the subjects of the optional module are planned according to individual curricula.

V. Modules of the curriculum

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, obligatory for doctoral students of all disciplines[3] (I-II sem.)				
1.	Higher education	20	1	*D_WWAT01, D_W05, D_W06, D_UWAT01, D_U03, D_K01, D_K02*
2.	Rules for conducting classes	10	1	*D_WWAT01, D_UWAT01, D_U03, D_U13, D_K01, D_K06*
3.	The process of applying for research funding	10	1	*D_W05, D_U7, D_U12, D_K01, D_K03,D_K04*
4.	Plan your experiment	16	1	*D_W04, D_U04, , D_K04*
5.	Methodology of conducting scientific research	10	1	*D_WAT02, D_U01-U05*
6.	Ownership and commercialisation of research	10	1	*D_W05, D_W06,D_U06*
7.	Scientometrics and bibliometrics in scientific activity	4	1	*D_W05, D_U08, D_K03, D_K04*
8.	Analysis of the research area[4]	20	2	*D_W01, D_W02, D_W03, D_W4, D_U08*
Optional modules related to the scientific discipline (III-VII sem.)				
1	Automation, electronics, electrical engineering and space technology	min. 200 hrs[5]	min. 20 points	*List of items attachment V.1 - page 11*
2	Informatics and Telecommunications			*List of items attachment V.2 - p. 13*
3	Civil Engineering, Surveying & Transportation			*List of items attachment V.3 - page 16*
4	Materials Science			*List of items attachment V.4 - p. 17*
5	Mechanical Engineering			*List of items attachment V.5 - page 19*
6	Chemical Sciences			*List of items attachment V.6 - p. 22*
7	Security Sciences			*List of items attachment V.7 - p. 23*
Internships at WAT (III-VII sem.) - in accordance with the individual education program				
1	Internships in the form of conducting classes or participating in them	20-180 hours	1	*D_WWAT01, D_UWAT01 D_K01*
Subjects taught outside the Military University of Technology and Other forms of education (III-VII sem.) - Optionally according to the individual training program				
1	Subjects outside MUT and, for example, internships, internships carried out at and outside MUT at another university or scientific institution in Poland or abroad	*The number of hours, ECTS credits and reference to learning outcomes is determined by the supervisor in an individualised learning programme*		

[3] in the case of education for foreigners in English, the subjects included in the basic module, concerning the issues of Polish regulations, may be replaced by other subjects determined by the Director of the Doctoral School.

[4] course carried out on an individual basis with a supervisor or supervisors or a supervisor and an assistant supervisor completed with a doctoral seminar

[5] the minimum number of hours of classes in the Optional Module may be reduced by the implementation of other forms of education, the sum of ECTS credits for the Optional Module and other forms of education may not be less than 20 points, while maintaining at least 100 hours of classes at MUT in the Optional Module

VI. Framework Programme

The framework programme includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

Lp.	Name Item /discipline Scientific	Curriculum content
Basic module, compulsory for all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Policy conducting classes	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	Process Inference for financing Research	The process of applying for funding for basic scientific research. Statutory activities, financing of domestic and foreign scientific internships for young scientists starting their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Education and Science, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Plan your experiment	Determined and randomized experiment plans. Measures of position and dispersion of measurement results. Assessment of the significance of the impact of input quantities on the output quantity. Specify a function that approximates the function of an object. Assessment of the adequacy of the function of the facility and the significance of its coefficients. Experiential optimization.
5.	Methodology Conduct research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that requires a solution – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6.	Proprietary Rights and commercializatio n Research	Basic information on the methods of intellectual property protection, in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection. Issues of commercialization of the results of scientific research and development works.
7.	Scientometrics l Bibliometrics in the activity Scientific	Scientometric and bibliometric indicators used in international bibliographic databases (Scopus, WoS), as well as national requirements related to the evaluation of researchers. Dissemination of scientific activities and research results, with particular emphasis on open access policy. The use of bibliographic databases and e-sources in scientific research. Tools supporting the collection of materials supporting the writing of scientific papers.
8.	Area Analysis Research	Seminar classes supervisor – PhD student. Analysis of the state of knowledge in the field of research issues selected by the doctoral student. Literature review. Defining the research problem (goal, research questions, hypotheses) and preliminary determination of the methodology. Preparation of a presentation for the first doctoral seminar. Preparation of a draft of an individual education program.

Lp.	Course name / discipline Scientific	Curriculum content
Optional modules related to the scientific discipline		
1	Automation, electronics, electrical engineering and space technology	*Annex VI.1 – page 25*
2	Informatics and Telecommunications	*Annex VI.2 – page 32*
3	Civil Engineering, Surveying & Transportation	*Annex VI.3 – page 42*
4	Materials Science	*Annex VI.4 – page 46*
5	Mechanical Engineering	*Annex VI.5 – page 52*
6	Chemical Sciences	*Annex VI.6 – page 61*
7	Security Sciences	*Annex VI.7 – page 64*

VII. Organisation of apprenticeships and other forms of education

Internships are carried out in the form of teaching classes or participation in conducting them for a minimum of 20 hours in semesters III - VII.

In special and justified cases (e.g. disability of a doctoral student), the supervisor may exempt the doctoral student from the obligation to undergo professional practice by indicating an additional optional subject or another form of education in the amount of at least 2 ECTS credits.

From the third to the seventh semester, it is allowed to carry out other forms of education, i.e. internships (other than teaching classes or participating in their conduct), internships in and outside the Military University of Technology, m.in. at a university, a domestic or foreign scientific institution, institutions and enterprises whose scope of activity is related to the subject of the doctoral dissertation. Other forms of education, their number of hours and the allocation of ECTS credits are decided by the supervisor in the Individualised Education Programme.

Apprenticeships and other forms of education are subject to credit for the descriptive grade (*zal / nzal*) in the academic year in which they took place in accordance with the rules set out in the Regulations of the Doctoral School of the Military University of Technology.

VIII. Educational plan

The education plan consists of a general part for all doctoral students of the year and an individual education plan for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

The Individual Education Plan for Doctoral Student Semesters III to VIII is created on the basis of the Individual Education Programme.

PLAN KSZTAŁCENIA W SZKOLE DOKTORSKIEJ OD ROKU AKADEMICKIEGO 2023/2024
WSZYSTKIE DYSCYPLINY NAUKOWE PROWADZONE W SZKOLE DOKTORSKIEJ

	moduły/*przedmioty*	ogółem godzin/ pkt ECTS		liczba godzin/pkt ECTS w semestrze:													
				I		II		III		IV		V		VI		VII		VIII	
		godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS	godz.	ECTS
Moduł podstawowy, obowiązkowy dla wszystkich dyscyplin																			
	Ogółem	**100**	**9**	**50**	**4**	**50**	**5**												
1	**Dydaktyka szkoły wyższej**	**20**	**1**	**20**	**1**														
2	**Zasady prowadzenia zajęć dydaktycznych**	**10**	**1**	**10**	**1**														
3	**Proces wnioskowania o finansowanie badań naukowych**	**10**	**1**			**10**	**1**												
4	**Planowanie eksperymentu**	**16**	**1**			**16**	**1**												
5	**Metodologia prowadzenia badań naukowych**	**10**	**1**			**10**	**1**												
6	**Prawa własności komercjalizacja badań naukowych**	**10**	**1**			**10**	**1**												
7	**Naukometria i bibliometria w działalności naukowej**	**4**	**1**			**4**	**1**												
8	**Analiza obszaru badawczego**	**20**	**2**	**20**	**2**														
Moduły fakultatywne związane z dyscypliną naukową - 298 przedmiotów																			
1	**Automatyka, elektronika i elektrotechnika - 54 przedmiotów**	**min. 200 godz.***	**min. 20 pkt ECTS***					**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
2	**Informatyka techniczna i telekomunikacja - 49 przedmiotów**																		
3	**Inżynieria lądowa i transport - 27 przedmiotów**																		
4	**Inżynieria materiałowa - 39 przedmiotów**																		
5	**Inżynieria mechaniczna - 78 przedmiotów**																		
6	**Nauki o bezpieczeństwie - 31 przedmiotów**																		
7	**Nauki chemiczne - 20 przedmiotów**																		
Praktyki zawodowe																			
1	*Praktyki zawodowe w formie prowadzenia zajęć lub uczestnictwa w ich prowadzeniu*	**20-180**	**1**					**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
Przedmioty realizowane w innej uczelni lub instytucji naukowej krajowej lub zagranicznej - opcjonalnie zgodnie z IPK																			
1	*Przedmioty realizowane w formie bezpośredniej i zdalnej*	***zgodnie z IPK***						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											
Inne formy kształcenia - opcjonalnie zgodnie z IPK																			
1	*np. praktyki, staże realizowane w i poza WAT, w innej uczelni lub instytucji naukowej krajowej lub zagranicznej*	***zgodnie z IPK***						**Zgodnie z Indywidualnym Programem Kształcenia (IPK)**											

** Suma punktów ECTS w ramach IPK musi wynosić min. 21 punktów, min. liczba godzin w Module fakultatywnym może być zmniejszona do 100 godz. i 10 pkt. poprzez realizację przedmiotów poza WAT i innych form kształcenia, którym przyporządkowano liczbę godzin i punktów ECTS*

IX. Internal system for ensuring the quality of education at the Doctoral School

The internal education quality assurance system at the Doctoral School is an element of the Education Quality Assurance System at the Military University of Technology.

As part of the preparation of doctoral students for high-level research work, the importance of continuous monitoring and systematic improvement of the quality of their education increases. The education quality policy, resulting from the mission and development strategy of the Academy, is implemented at the Academy by setting appropriate goals and quality standards, as well as by implementing, continuously monitoring
and improving the internal quality assurance system.

The scope of the internal education quality assurance system at the Doctoral School includes in particular:

1) monitoring and analysis of the formal and legal side of the teaching process;
2) periodic review and updating of education programs;
4) analysis of the conditions for the implementation of the teaching process;
5) monitoring factors affecting the quality of education;
6) analysis of the functioning and development of methods for improving the quality of education.

Annex V.1

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: automation, electronics, electrical engineering and space technologies

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Computer Network Administration**	**20**	**3**	*D_W03*	*winter*
2.	**Acoustic Electronics**	**30**	**3**	*D_W04, D_W05*	*winter*
3.	**Computer-aided analysis of experimental data**	**30**	**3**	*D_W03, D_U06*	*winter*
4.	**Smart Antennas**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
5.	**Digital Image Processing**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
6.	**Optical Radiation Detectors**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
7.	**Electromechanical energy and signal converters**	**30**	**3**	*D_W01, D_U05*	*winter*
8.	**Laser Physics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
9.	**Physics of laser media**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
10.	**Photovoltaics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
11.	**Supercontinuum Radiation Generation**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
12.	**Imaging Information Engineering**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
13.	**Encoding and recognition of radio transmissions**	**30**	**3**	*D_U05*	*winter*
14.	**Crystallography**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
15.	**Laser absorption spectroscopy in gas sensors**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
16.	**Laser-plasma X-ray and extreme ultraviolet (EUV) sources**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
17.	**Lasers for medical applications**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
18.	**Pico- and femtosecond lasers**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
19.	**Fiber lasers**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
20.	**Mathematical models of the electromagnetic field**	**30**	**2**	*D_W02, D_W03*	*winter*
21.	**Finite Element Method**	**30**	**3**	*D_W02, D_W03*	*lukewarm*
22.	**Methods of analysis and measurement of random signals**	**30**	**3**	*D_W02, D_U05*	*lukewarm*
23.	**Data mining methods and tools**	**30**	**3**	*D_W02, D_W04*	*winter*
24.	**Methods of logical synthesis**	**30**	**3**	*D_W02, D_W03*	*winter*
25.	**Minimizing the electromagnetic susceptibility of infiltration of IT devices**	**30**	**3**	*D_U05*	*winter*
26.	**Nonlinear Laser Conversion**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
27.	**Scientific and engineering calculations**	**30**	**3**	*D_W04*	*winter*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
28.	**Optoelectronics in safety systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
29.	**Coherent Light Optics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
30.	**Plasma in science and technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
31.	**Remote Sensing Basics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
32.	**Basics of knowledge about viruses and other pathogens for engineers**	**30**	**3**	*D_W01, D_W02, D_U01, D_U07, D_K01*	*winter*
33.	**Measurements of basic parameters of laser radiation**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
34.	**Designing safety systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
35.	**Programmable and Purpose-Built Circuits**	**30**	**3**	*D_W01, D_U05*	*lukewarm*
36.	**Acoustic sensors**	**20**	**2**	*D_W04, D_W05*	*winter*
37.	**Microwave sensors in radiolocation**	**20**	**2**	*D_W02, D_U04*	*lukewarm*
38.	**Smart radio networks**	**30**	**3**	*D_W01, D_W03*	*winter*
39.	**Optical Spectroscopy for Life Sciences**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	
40.	**Digital systems in optoelectronic devices**	**30**	**2**	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*	*winter*
41.	**Test and measurement systems in the test laboratory**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
42.	**Fiber optic technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
43.	**Terahertz technique**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
44.	**Information concealment technique (steganography)**	**30**	**3**	*D_W01, D_W02, D_U05*	*lukewarm*
45.	**Techniques in Biomedical Engineering**	**30**	**3**	*D_W01, D_W02, D_U01, D_U07, D_K01*	*winter*
46.	**Field theory**	**30**	**3**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
47.	**Thermal imaging and infrared technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
48.	**Optical Radiation Detection Systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
49.	**Laser beams**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
50.	**Modern transducers measuring physical quantities**	**30**	**3**	*D_W01, D_U05*	*winter*
51.	**Selected issues of the operation of anthropotechnical systems**	**30**	**3**	*D_W08, D_U05 i 06*	*lukewarm*
52.	**Advanced microelectronics technologies**	**30**	**3**	*D_W01, D_U05*	*lukewarm*
53.	**Applications of lasers in technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
54.	**Advanced techniques for digital system design in FPGAs**	**30**	**3**	*D_W02, D_W03, D_U07, D_U09, D_K05*	*lukewarm*

Annex V.2

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: technical informatics and telecommunications

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Quantum Algorithms III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
2.	**Algorithm Analysis III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
3.	**Analysis and synthesis of visual information III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
4.	**Next-generation wireless systems (NG)**	**20**	**2**	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*lukewarm*
5.	**ICT Systems Diagnostics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
6.	**Efficiency of ICT systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
7.	**Elements of forecast theory III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
8.	**Software Evaluation III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
9.	**Physical Foundations of Quantum Information III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
10.	**Computer Graphics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
11.	**Software Quality Engineering III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
12.	**Cryptology III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
13.	**Mathematical Methods of Decision Support III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
14.	**Discrete Mathematics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
15.	**Generative and aspective methods in manufacturing software III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
16.	**Numerical methods III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
17.	**Multi-Criteria Optimization Methods III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
18.	**Mathematical Modelling III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
19.	**Modeling and verification of ICT networks III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
20.	**Modeling Conflict Situations III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
21.	**Business Process Modeling, Simulation and Analysis III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
22.	**Software Reliability III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05,*	*lukewarm*

lp.	Item Name	numbe r of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
				D_U07,D_K01,D_K03	
23.	**Reliability of Systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
24.	**Optimization III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
25.	**Probabilistic III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
26.	**Stochastic Processes III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
27.	**Image Recognition and Processing III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
28.	**Neural networks and fuzzy logic III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
29.	**Smart radio networks**	**20**	**2**	*D_W01, D_W03,D_U010, D_K03, D_K05*	*winter*
30.	**Stochastic Exploitation Models III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
31.	**Computer Simulation III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
32.	**Database Systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
33.	**ICT systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
34.	**Decision support systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
35.	**Artificial Intelligence III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
36.	**Theoretical foundations of computer science III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
37.	**Graph and Network Theory III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
38.	**Project and Process Management III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
39.	**Complex Data Structures III**	**20**	**2**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
40.	**5G network application for military**	**30**	**3**	*D_W01,D_W02,D_W03,D_ U01D_U02,D_U04,D_U05*	*lukewarm*
41.	**Advanced cryptanalysis tools**	20	2	*D_W01, D_W02,D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
42.	**Probabilistic graph models: representation**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
43.	**Probabilistic graph models: the basics of inference**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
44.	**Probabilistic Graph Models: Inference Methods**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
45.	**Probabilistic graph models:**	20	2	*D_W01,D_W02, D_W03,*	*winter*

lp.	Item Name	numbe r of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
	parameter estimation			*D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	
46.	**Probabilistic graph models and hybrid models**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
47.	**GNSS – Systems and signals" (GNSS)**	20	2	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*winter*
48.	**Multidimensional Data Processing (WDP)**	20	2	*D_W01; D_W02; D_W03; D_U10; DU_04; D_K03; D_K05*	*winter*
49.	**Automated Battlefield Database Systems (SBD-ZPW)**	20	2	*D_W01; D_W02; D_W03; D_U10; DU_04, D_K03; D_K05*	*winter*

Annex V.3

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: civil engineering, geodesy and transport

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Safety and reliability of building structures	20	3	*D_W03; D_W05; D_U02; D_K02*	*winter*
2.	Dynamic interaction of building structures with a soil medium	20	2	*D_W02; D_U01; D_K05*	*lukewarm*
3.	Environmental physics	20	2	*D_W03; D_U04; D_K02*	*lukewarm*
4.	Modeling of thermal and humidity processes	20	2	*D_W03; D_U04; D_K03*	*lukewarm*
5.	Identification of loads and structural systems	20	2	*D_W02; D_U02; D_K02*	*winter*
6.	Investment process in the construction industry	20	2	*D_W01; D_U04; D_K05*	*lukewarm*
7.	Mechanics of road and airport runway soil foundations	20	3	*D_W03; D_U02; D_U04; D_K03*	*winter*
8.	Test Methods for Stiffness and Load-Bearing Capacity of Road and Airport Pavements	20	2	*D_W03; D_U07; D_K07*	*lukewarm*
9.	Design methods for folding bridge structures	20	2	*D_W03; D_U01; D_U03; D_K01*	*winter*
10.	Design methods of the experiment	20	3	*D_W02; D_U01; D_K01*	*lukewarm*
11.	Modeling the Behavior of Reinforced Concrete Elements and Structures	20	2	*D_W02; D_U01; D_K01*	*winter*
12.	Geometric and Physical Nonlinearities in Structural Mechanics	20	2	*D_W03; D_U04; D_K05*	*lukewarm*
13.	Explosive effects on defensive structures	20	2	*D_W02; D_U01; D_K05*	*winter*
14.	Scheduling and costing systems for construction works	20	2	*D_W06; D_U06; D_K08*	*lukewarm*
15.	Engineering of building materials	20	3	*D_W04, D_U04, D_K05*	*winter*
16.	Cartographic methods of research	20	2	*D_W02, D_U05, D_U07, D_K03, D_K05*	*lukewarm*
17.	Spatial data exploration	20	2	*D_W02, D_W04, D_UWAT02, D_U01, D_U05, D_K03, D_K05*	*winter*
18.	Data science in geospatial research	20	2	*D_W02,D_W03,D_UWAT02, D_U01, D_U05, D_K03, D_K04*	*lukewarm*
19.	Advanced methods of implementation of studies photogrammetric	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
20.	Programming in spatial information systems	20	2	*D_W02, D_W05, D_U06, D_U10, D_K03, D_K06*	*winter*
21.	Reference systems in geosciences	20	3	*D_W02,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
22.	Global Geodetic Observing System	20	3	*D_W01,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
23.	Modern photogrammetric techniques	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*lukewarm*
24.	Selected numerical methods in geodesy	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
25.	Methods of parallel data processing	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*lukewarm*
26.	Mathematical foundations of digital image processing	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
27.	Numerical methods with linear algebra	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*lukewarm*

Annex V.4

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Structural studies by X-ray diffraction	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
2.	Structural studies by scanning microscopy	20	2	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*	*winter*
3.	Mechanical Properties Testing of Engineering Plastics	20	2	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	20	2	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*	*winter*
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	20	2	*D_W01, D_W04, D_U05, D_K03*	*winter*
6.	Semiconductor materials for optoelectronic applications	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
7.	Nano and ultra-crystalline construction materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
8.	Nanoporous anodic aluminum oxide: synthesis, Design & Applications	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U03, D_K01, D_K03, D_K05*	*lukewarm*
9.	Non-telecommunications applications of fiber optics	20	2	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
10.	Measurements of machine and equipment parts with using coordinate measuring techniques	20	2	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*	*lukewarm*
11.	Experiment planning and data analysis with using Origin and Statistica	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
12.	Basic properties of liquid crystals	20	2	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*	*winter*
13.	Keysight Vee and Lab View in Control and data processing	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*	*winter*
14.	Designing technological processes for incremental Direct Deposition methods	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
15.	Dielectric spectroscopy	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*lukewarm*
16.	Structural Determinants of Material Properties	20	2	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*	*winter*
17.	Modern methods of material characterization	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*winter*
18.	Contemporary information imaging systems and directions of their development	20	2	*D_W01, D_W06, D_U01, D_U02, D_U05, D_K03, D_K04*	*winter*
19.	High-energy ball milling and mechanical synthesis	20	2	*D_W01, D_W01, D_U05, D_K03*	*winter*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
20.	Advanced materials for hydrogen storage	20	2	*D_W01, D_W03, D_U01, D_K04*	*lukewarm*
21.	Basics of plasmonics and metamaterials	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
22.	Optoelectronic imaging and information processing techniques	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
23.	Selected Materials and Functional Structures for Photonic Applications	20	2	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*lukewarm*
24.	Computer Image Analysis in Materials Science	20	2	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*lukewarm*
25.	Additive manufacturing of functional materials	20	2	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
26.	Methods for amplifying light emission from broadband semiconductor nanostructures	20	2	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U07, D_U10, D_K01, D_K03, D_K04, D_K09*	*winter*
27.	Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals	20	2	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U10, D_K03, D_K04, D_K05, D_K09*	*winter*
28.	Modeling of semiconductor devices.	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*winter*
29.	High-entropy alloys – synthesis, structure, research and properties	20	2	*D_W01, D_W01, D_U05, D_K03*	*winter*
30.	Additive manufacturing of phased alloys intermetallic	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
31.	Combinatorial Materials Manufacturing and Testing Engineering	20	2	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
32.	Reactive mechanical grinding as a method for the synthesis of modern hydrogen storage materials in the solid phase.	20	2	*D_W01, D_W01, D_U05, D_K03*	*winter*
33.	Additive techniques with elements of reverse engineering	20	2	*D_W02, D_W04, D_UWAT02, D_U03, D_U07, D_K03, D_K05*	*winter*
34.	Overview of additive techniques used in modern technology	20	2	*D_W01, D_W03, D_UWAT02, D_D_U10, D_K03*	*winter*
35.	Selected issues in 3D printing	20	2	*D_W01, D_UWAT02,D_U01, D_U08,D_K04, D_K05*	*winter*
36.	Researcher's workshop 1 – tools for writing scientific texts	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
37.	Researcher's workshop 2 – writing scientific articles	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
38.	Researcher's Workshop 3 – Writing Scientific Articles	20	2	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
39.	Quantum mechanics in examples	20	2	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*winter*

Annex V.5

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: mechanical engineering

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Numerical Analyses in Load-Bearing Structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
2.	Autonomy of mobile robots	30	3	*D_U04, D_W03, D_K01*	*winter*
3.	Non-destructive testing of aircraft	30	3	*D_W02; D_W05; D_U01; D_K05*	*winter*
4.	Biomechanics of human body movement during a road accident	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*lukewarm*
5.	Construction and operation of industrial robots	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
6.	Digital signal processing	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
7.	Dynamics of mechatronic system design	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*	*lukewarm*
8.	Dynamics of car movement	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*	*lukewarm*
9.	Dynamics and modeling of hydrostatic systems	30	3	*D_U04, D_W04, D_K01*	*winter*
10.	Dynamics of multi-member systems	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
11.	Impulse loads of motor vehicles – selected issues	20	2	*D_W04, D_U04, D_K09*	*winter*
12.	Computer-aided operation of machines	20	2	*D_W02, D_U05, D_K05*	*lukewarm*
13.	Shaping a safe car body	20	2	*D_W01, D_U04, D_K01, D_K05*	*lukewarm*
14.	Composite materials in mechanical engineering	30	3	*D_W01, D_W01, D_U04, D_K01, D_K05*	*lukewarm*
15.	Finite Element Method	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
16.	Methods of analysis of numerical experimental research results	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
17.	Methods of testing the condition of machines	30	3	*D_W03, D_U05, D_K01, D_K03*	*winter*
18.	Experimental methods for investigating the thermophysical properties of solids	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*lukewarm*
19.	Methods and techniques for testing the mechanical properties of materials	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*winter*
20.	Numerical Methods in Engineering Applications	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
21.	Numerical Methods in Mechanical Engineering	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
22.	Methods for designing and optimizing aircraft structures	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*	*lukewarm*
23.	Constitutive Models of Materials in FEM Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
24.	Modelling of heat transfer processes	30	3	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*	*winter*
25.	Modeling and simulation of mechatronics issues	30	3	*D_W04, D_U04, D_K01*	*lukewarm*
26.	Modeling and simulation of nonlinear mechanical problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03,*	*lukewarm*

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
				D_K05	
27.	Parametric modeling and structural optimization with FEM	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
28.	Flow modeling	30	3	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
29.	Modeling machine motion	20	2	*D_U04, D_W04, D_K01*	*lukewarm*
30.	Modeling composite structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
31.	Modeling of the Contact Phenomenon in Structural Mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
32.	Modeling and research of the processes of cooperation between the wheel and the road	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
33.	Modeling of car traffic and controls	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
34.	Modern technologies for bonding structural materials	30	3	*D_W01, D_W02, D_U05, D_K01, D_K05*	*lukewarm*
35.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	20	2	*D_U04, D_W03, D_K01*	*winter*
36.	Renewable energy sources	30	3	*D_W06, D_U WAT02, D_K07*	*winter*
37.	CAE Engineering Software	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
38.	Experiment planning and optimization of mechanical objects	30	3	*D_W04, D_U04, D_K05*	*winter*
39.	Basics of road safety	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*winter*
40.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*lukewarm*
41.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*winter*
42.	Fundamentals of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
43.	LabVIEW environment in experimental research	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
44.	Starting processes of internal combustion engines	30	3	*D_W04, D_U04, D_K01*	*lukewarm*
45.	Programming of control systems for unmanned working machines and robots	30	3	*D_U04, D_W03, D_K01*	*winter*
46.	Mechatronic sensors	30	3	*D_W03, D_W04, D_U06, D_K01, D_K04*	*winter*
47.	Condition monitoring systems	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
48.	Aircraft Operation Systems	30	3	*D_W03; D_U01; D_K03*	*winter*
49.	Control systems in mechanical engineering	30	3	*D_U04, D_W03, D_K01*	*lukewarm*
50.	Technologies for the production and processing of composite materials	30	3	*D_W01, D_W02, D_U04, D_K01, D_K05*	*lukewarm*
51.	Selected solutions in the field of automotive technology and car motion	20	2	*D_W01, D_W03, D_U04 D_K01, D_K05*	*lukewarm*
52.	Theory and organization of machine operation	30	3	*D_W04, D_U06, D_K03*	*winter*
53.	Thermomechanics of materials and studies of thermophysical properties	30	3	*D_W03, D_W04, D_U01, D_K03*	*winter*
54.	Tribology	30	3	*D_W03, D_U04, D_K05*	*winter*
55.	Durability of aircraft structures	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01,*	*lukewarm*

lp.	Item Name	numbe r of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
				D_K03, D_K05	
56.	Introduction to the equations of mathematical physics	30	3	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*	*lukewarm*
57.	Modern machine and vehicle drive systems	30	3	*D_W03, D_U04, D_K05*	*winter*
58.	Modern test methods for internal combustion engines and vehicles	30	3	*D_W04; D_U01; D_U02; D_U03; D_U04; D_U05; D_UWAT01;*	*winter*
59.	Selected methods and techniques of temperature measurement	30	3	*D_W03, D_W04, D_U04, D_K05*	*lukewarm*
60.	Selected problems of rocket technology	30	3	*D_W03, D_U04, D_K05*	*winter*
61.	Selected issues of waste gas treatment from motor vehicles	30	3	*D_W01; D_W02; D_W03; D_K03; D_K05; D_U010;*	*lukewarm*
62.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	30	3	*D_W01; D_W02; D_W03; D_U05; D_K01; D_K03; D_K05;*	*winter*
63.	Selected issues of modern programming - introduction to modern programming languages.	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
64.	Fatigue strength and fracture mechanics of materials and structures	30	3	*D_W01, D_U04, D_K01*	*lukewarm*
65.	Advanced methods of manufacturing products from sintered powders	30	3	*D_W04, D_U04, D_K01*	*lukewarm*
66.	Advanced ballistics, modeling, and simulation	30	3	*D_W01, D_U04, D_K01*	*lukewarm*
67.	Advanced Mathematics	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
68.	Advanced modeling in structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
69.	Advanced measurement systems	30	3	*D_W04, D_U04, D_K01*	*winter*
70.	Advanced Materials Testing Methods	30	3	*D_W01, D_W02, D_W04, D_U02, D_U04, D_U05, D_K01, D_K05*	*lukewarm*
71.	Application of experimental mechanics in scientific research 1	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
72.	Application of experimental mechanics in scientific research 2	40	4	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*lukewarm*
73.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	30	3	*D_W01, D_W02, D_W03 D_U05, D_K01, D_K03, D_K05*	*lukewarm*
74.	Selected issues of vibration theory	20	2	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
75.	Selected issues in acoustoelectronics	30	3	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*lukewarm*
76.	Numerical methods	30	3	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
77.	Electromagnetic field theory	30	3	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
78.	Quantum mechanics	30	3	*D_W01, D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*

Annex V.6

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: chemical sciences

lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Analysis of Chemical Warfare Agents	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*	*winter*
2.	Chemistry and technology of liquid crystal materials	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*	*lukewarm*
3.	Chemistry and technology of high-energy materials	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*	*lukewarm*
4.	Chemical Foundations of Environmental Pollution	20	2	*D_W02, D_W03, D_UWAT02, D_K01, D_K03*	*lukewarm*
5.	Physics and chemistry of carbon materials	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*	*lukewarm*
6.	Physicochemical aspects of the explosion	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*	*lukewarm*
7.	History of chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
8.	Ionization methods in analytics	20	2	*D_W03, D_W04, D_UWAT02, D_K01*	*winter*
9.	Methods for preparing samples for analysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
10.	Spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
11.	Modern nanoporous materials	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*	*winter*
12.	Modern methods of synthesis of functional organic compounds	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*lukewarm*
13.	Signal Processing in Analytical Chemistry	20	2	*D_W03, D_W04, D_U05, D_K03*	*lukewarm*
14.	Synthesis of liquid crystals	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*winter*
15.	Introduction to Spectroscopy	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
16.	Modern analytical chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
17.	Advanced pyrotechnics	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
18.	Application of gas chromatography in physicochemical studies	20	2	*D_W WAT01, D_W01, D_W02, D_U WAT01, D_U WAT02, D_K01, D_K03*	*lukewarm*
19.	Polymer chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*lukewarm*
20.	Modeling and simulation computer programs in chemistry	40	4	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*	*winter*

Annex V.7

to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: security sciences

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	Social research in security sciences	40	4	*D_W WAT01; D_W01; D_W06; D_UO3; D_K03;*	*winter*
2.	Statistical methods in social research	40	4	*D_WO4; D_U O3; D_U04; D_KO1; D K03;*	*lukewarm*
3.	Security risk management	30	3	*D_WO1; D_W03; D_UO3;*	*lukewarm*
4.	Security Systems Project Management	30	3	*D_W03; D_U04; D_K05;*	*lukewarm*
5.	Safety Systems Engineering	30	3	*D_W03; D_W02; D_UO6; D_U10; D_KO5;*	*winter*
6.	Safety propaedeutics	30	3	*D_W02; D W05; D_U01; D_K05;*	*winter*
7.	Strategies and concepts of state security management	30	3	*D_W02; D_U04; D_KO5;*	*winter*
8.	Crisis management in public administration	30	3	*D_WO1; D_W03; D_UO3; D_U12;*	*lukewarm*
9.	Universal safety	30	3	*D_W02; D_W03; D_U01; D_K07;*	*lukewarm*
10.	Internal security	30	3	*D_W02; D_W03; D_KO5; D_KO7;*	*lukewarm*
11.	Survey data analysis	20	2	*D_WO4; D_U04; D_KO1;*	*winter*
12.	Multivariate analyses	20	2	*D_WO4; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
13.	Evaluation research procedures	20	2	*D_WO4; D_U04; D_U05; D_KO1; D K03*	*lukewarm*
14.	Logic and theory of argumentation	20	2	*D_WO4; D_U01; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
15.	Forecasting and simulations in security	20	2	*D_W03; D_W04; D_U WAT01; D_U05; D U13; D_K03; D K04; D K05;*	*lukewarm*
16.	Modern technologies in security	20	2	*D_WO1; D_WO2; D_U WATO1; D_UO6; D K03;*	*lukewarm*
17.	Philosophy of security sciences	20	2	*D_W02; D_W03; D_U01; D_U05; D_KO1; D_K03;*	*winter*
18.	Modern terrorism	20	2	*D_W03; D_W06; D_U05; D_UO8; D_U09; D_KO1; D_KO6;*	*winter*
19.	Morale and Security Culture in National and International Relations	20	2	*D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*	*lukewarm*
20.	Safety history	20	2	*D_W02; D_W03; D_U Wato2; D_U05; D_K03; D_KO9;*	*winter*
21.	Strategic communication	20	2	*D_WO1; D_WO3; D_UO6; D_U10; D_KO1; D_KO5*	*lukewarm*
22.	Political security sector	20	2	*D_WO2; D_WO3; D_UO8D_U12; D_K02;*	*winter*
23.	Shaping military security in the 21st	20	2	*D_W04; D_U WAT01; D_U WAT02; D_U05;*	*winter*

Lp.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
	century			*D_U13; D K03; D_K04; D_K05;*	
24.	Information security	20	2	*D_W06; D_U01; D_K05;*	*winter*
25.	The economic dimension of safety	20	2	*D_W03; D_U WAT02; D_U05; D_K03; D_K04; D_K05;*	*winter*
26.	Energy security in the face of socio-economic transformation	20	2	*D_W04; D_U WAT01; D_U WAT02; D U05; D_U13; D_K03; D_K04; D_K05;*	*lukewarm*
27.	Social Determinants of the Security of Modern States	20	2	*D_W03; D_W06; D_U04; D_U05; D_KO5; D_K07;*	*winter*
28.	Combating and preventing corruption	20	2	*D_WO1; D_W06; DU01; D U02; DU01; D U12; D_K07; D_K02;*	*lukewarm*
29.	Operational methods of combating serious criminal crime	20	2	*D_WO1; D_W03; DU01; D_U02; D_K07;*	*lukewarm*
30.	Environmental security on a global, regional and national scale	20	2	*D _W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D 1.113; D_K03; D_K04; D_K05;*	*winter*
31.	Cultural security factors	20	2	*D_W03; D_W06; D_U04; D_U07; D_U10; D_K04; D_K05;*	*lukewarm*

Annex VI.1
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics, electrical engineering and space technologies

Lp.	Item Name	Curriculum content
1.	**Computer Network Administration**	Human-machine relations. Socio-technical system. Communication of network devices. Fundamentals of Windows and Linux administration. Configuration of network devices and multimedia services in wired (Ethernet) and radio (5G) networks. Security, reliability and quality of ICT networks.
2.	**Acoustic Electronics**	Technical applications of elastic waves. Elastic waves in solids and their types. Elastic waves in confined media. Ferroelectric materials. Piezoelectricity. Electrostriction. Excitation and detection of acoustic volume waves. Acoustic volume wave filters and resonators. Construction and properties of interdigital transducers. Filters and dispersion lines with acoustic surface wave. Acoustic convolutors and Fourier processors. Acoustoelectronic sensors of mechanical quantities. Acoustoelectronic activators. Remote identification systems. Basics of synthesis of acoustic surface wave systems. Matching acoustoelectronic circuits to external circuits
3.	**Computer-aided analysis of experimental data**	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of uni- and multivariate data, processing of multivariate experimental results by means of linear transformations, problems of discrimination including methods of minimal-distance classification, nearest proximity, k-means and hierarchical grouping.
4.	**Smart Antennas**	Basic properties of smart antennas. Construction of antenna arrays. Applied solutions for shaping the characteristics of smart antennas. An overview of algorithms used in smart antennas. The principle of operation of adaptive patterns, the properties of their components and the configurations in which they are used in practice. Simulation models of the adaptation process.
5.	**Digital Image Processing**	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
6.	**Optical Radiation Detectors**	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, p-n, pin, APD photodiodes, with Schottky barrier, UV, VIS, IR detectors, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages. Detectors from type II superlattices. QWIP detectors. Barrier detectors.
7.	**Electromechanical energy and signal converters**	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements.
8.	**Laser Physics**	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
9.	**Physics of laser media**	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction.

Lp.	Item Name	Curriculum content
		Energy levels of transition group metal ions. Phenomena of energy transfer between ions in active media.
10.	**Photovoltaics**	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.
11.	**Supercontinuum Radiation Generation**	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
12.	**Imaging Information Engineering**	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality – key system components, application solutions.
13.	**Encoding and recognition of radio transmissions**	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
14.	**Crystallography**	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
15.	**Laser absorption spectroscopy in gas sensors**	Gas detection methods and defining gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
16.	**Laser-plasma radiation sources X-ray and extreme ultraviolet (EUV)**	Methods of producing X-rays and extreme ultraviolet radiation (EUV), basics of laser-generated plasma physics and X-ray and EUV optics, principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), examples of the use of these sources in science and modern technology.
17.	**Lasers for medical applications**	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications and the therapeutic and diagnostic effects obtained.

Lp.	Item Name	Curriculum content
18.	**Pico- and femtosecond lasers**	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
19.	**Fiber lasers**	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals - selected issues.
20.	**Mathematical models of the electromagnetic field**	Analytical and numerical methods of calculating the electromagnetic field. Differential relationships. Distribution. Orthogonal functions in wireless communication (LTE and 5G) and radiolocation. Wave propagation in materials and metamaterials. Simplified analytical models for calculating the radiation field. Techniques of calculation using potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the distant zone criterion. Computational numerical electromagnetism - differential methods.
21.	**Finite Element Method**	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
22.	**Methods of analysis and measurement of random signals**	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
23.	**Data mining methods and tools**	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
24.	**Methods of logical synthesis**	Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
25.	**Minimizing the electromagnetic susceptibility of infiltration of IT devices**	Electromagnetic disturbances as revealing emission. Measurement of the level of electromagnetic disturbance emissions. Uncertainty of measuring the level of electromagnetic disturbance emissions. Assessment of the quality of the results of measurements of the level of emission of disturbances. Protection of IT devices against electromagnetic penetration of information in the form of shielding and filtration. Factors affecting the required shielding efficiency and insertion loss of power supply filters. Methodologies for measuring parameters affecting the level of electromagnetic safety (shielding efficiency, insertion loss of power supply filters and signal filters, absorption and dispersion losses of materials). Examples of applications for the protection of IT devices against electromagnetic penetration of information.

Lp.	Item Name	Curriculum content
26.	**Nonlinear Laser Conversion**	Elements of crystallography and crystal optics. Properties of uniaxial and biaxial crystals (KDP, LiNbO3, KTP, BBO, LBO, etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector synchronizm. Generation II of the harmonic of light and the summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits
27.	**Scientific and engineering calculations**	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
28.	**Optoelectronics in safety systems**	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.
29.	**Coherent Light Optics**	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.
30.	**Plasma in science and technology**	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
31.	**Remote Sensing Basics**	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron paramagnetic resonance (EPR) (microwave spectroscopy). Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems. Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.
32.	**Basics of knowledge about viruses and other pathogens for engineers**	Presentation of selected issues of microbiology, epidemiology and public health in the light of the latest scientific discoveries. Using the achievements of bioinformatics to describe the world of microorganisms. Discussion of contemporary threats to human and animal health, basic groups of pathogens and ways to prevent infections and infestations. Zoonotic diseases. Gene and genome engineering, biotechnology, threats to ecosystems. The concept of One Health. Basics of immunoprophylaxis and hygiene. Pathogens are particularly dangerous in states of war and natural disasters.
33.	**Measurements of basic parameters of laser radiation**	Measurement methods of radiation spectrum, radiation power and energy, pulse duration and pulse repetition frequency, radiation beam divergence angle. Familiarizing yourself with the basics of laser safety
34.	**Designing safety systems**	Security strategy and principles for creating technical protections. Normative principles and a set of good industry practices. The range of technical protection measures that can be applied. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor and outdoor applications. Working conditions and restrictions on this account. Structure of the technical and detailed design. The scope of the technical executive design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Rules for detailed design and cost estimation. Design study in the field of technical and detailed design. Required resources to lay the groundwork for the project. Threat analysis. The concept of technical protection of the security

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		system. Rules for conducting a hazard analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. Attack scenarios and verification of the possibility of technical protection against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Methods of description and graphical representation of the technical design. The way documentation is organized. Examples of technical executive designs of critical infrastructure facilities. Documents related to the technical detailed design. Rules for the development of an investor's and "blind" cost estimate. The need to compile technical catalogues and technical data sheets of devices.
35.	**Programmable and Purpose-Built Circuits**	Technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). Principles of digital circuit topography design, power distribution and clock distribution, I/O buffers, IP blocks, and design tools.
36.	**Acoustic sensors**	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
37.	**Microwave sensors in radiolocation**	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
38.	**Smart radio networks**	Smart radio network concept. CR architectures. Semantic context of CR. Problems of teaching in the CR system. Dynamic spectrum management. Problems of reception in CR. Ad-hoc CR networks, collaborative MIMO. Standards for CR networks. Security problems in CR. Current research programs in the area of CR.
39.	**Optical Spectroscopy for Life Sciences**	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński diagram Spectroscopic arrangement – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
40.	**Digital systems in optoelectronic devices**	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
41.	**Test and measurement systems in the test laboratory**	Signal conditioning systems. Control and measurement systems. Measurement signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
42.	**Fiber optic technology**	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.
43.	**Terahertz technique**	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
44.	**Information concealment technique (steganography)**	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of hiding data –

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		cases and scenarios of action.
45.	**Techniques in Biomedical Engineering**	Fundamental issues and research techniques in biology and biomedicine will be discussed, including the main points of bioengineering and biotechnology. Thus, the skills necessary to undertake interdisciplinary research in these areas of science will be developed. The principles of construction of essential research equipment will be presented, including measurements based on fluorescence excitation. The possibilities of bioinformatics analysis and international databases will be discussed. In addition, the principles of good laboratory practice and safe work in biomedical laboratories will be presented. Requirements for conducting reliable measurements and elaborating results in biomedical research and medical bioengineering will also be discussed.
46.	**Field theory**	Basic concepts and equations of the theory of the electromagnetic field. Maxwell's equations, Properties of mediums and boundary conditions. Fields at the boundary of medium separation, Electromagnetic field energy. Types of electromagnetic phenomena, Electrostatics and magnetostatics. Stationary and quasistationary electromagnetic fields, Maxwell's equations in complex form for harmonic waveforms, Electromagnetic waves. Wave equation for the area without sources, Uniform plane wave. Propagation parameters of a homogeneous plane wave, Propagation of a homogeneous planar wave in a lossless dielectric, Propagation of a homogeneous planar wave in lossy dielectrics, Propagation of a homogeneous planar wave in a good conductor, Structure of a homogeneous planar wave, Reflection and refraction of a homogeneous planar wave at a planar boundary of two different mediums. Reflection and refraction of a homogeneous plane wave at the boundary of two different dielectrics, Reflection of a homogeneous plane wave propagating in a dielectric from the plane surface of a conductive medium Electromagnetic potentials and radiation, Potentials of alternating fields, delayed potentials. Hertz vector potential, Field of elementary oscillator, Electromagnetic field at short distances from the oscillator, Electromagnetic field at long distances from the elementary oscillator, Wave phase, wave type, phase velocity, Propagation of waves in parallel systems of conductors and in waveguides, Transverse electromagnetic wave TEM, Transverse magnetic wave TM in a rectangular waveguide, Transverse electric wave TE in a rectangular waveguide, Base Type, Cuboid Cavity Resonator
47.	**Thermal imaging and infrared technology**	Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Radiometric calibration of a thermal imaging camera and its impact on the accuracy of remote measurement of temperature and radiation power. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Multi and hyperspectral infrared systems. Active thermal imaging, measurement capabilities and prospects for its application. Infrared imaging polarimetry.
48.	**Optical Radiation Detection Systems**	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
49.	**Laser beams**	Modeling of laser beams, Measurements of laser beam parameters. Design of optical paths of laser beams. Selected systems and systems of laser beam generation, shaping of laser beam transverse profiles, Folding of laser beams, propagation of laser beams in the atmosphere. Selected applications of laser beams in military science, technology and technology.
50.	**Modern transducers measuring physical quantities**	The concept of a measuring transducer and their classifications. Static and dynamic properties of transducers. Resistance strain gauges. Capacitive, piezoelectric, inductive, magnetoelastic, thermoelectric and pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic and acoustic transducers. Photoacoustic and photonic transducers. Integrated transducers.
51.	**Selected issues of the operation of anthropotechnical systems**	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
52.	**Advanced**	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast

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	microelectronics technologies	nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy structure of semiconductors.
53.	**Applications of lasers in technology**	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.
54.	**Advanced techniques for digital system design in FPGAs**	The Advanced FPGA Digital Systems Design Techniques course discusses issues related to, m.in others, the development of integrated digital systems in FPGAs, topographic design, effective use of design constraint attributes, preparation of functional tests, and good design practices. The course is divided into a theoretical part (lectures) and a practical part (laboratories and a project), and the results of the project work carried out are discussed at the seminar. Before taking the course, it is advisable to know the Hardware Description Languages (HDL) and the architecture of FPGAs.

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: technical informatics and telecommunications

Lp.	Item Name	Curriculum content
1.	**Quantum Algorithms III**	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	**Algorithm Analysis III**	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	**Analysis and synthesis of visual information III**	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	**Next-generation wireless systems (NG)**	Development trends. Networking. Radio interface techniques. Development of services and applications. Organization and management in NG systems. Applications of artificial intelligence (AI) and machine learning (ML). Bulk systems, D2D (Device-to-Device) systems, transport systems. Cognitive NG networks. Green communication.
5.	**ICT Systems Diagnostics III**	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
6.	**Efficiency of ICT systems III**	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
7.	**Elements of forecast theory III**	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.
8.	**Software Evaluation**	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation.

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	III	Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
9.	**Physical Foundations of Quantum Information III**	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
10.	**Computer Graphics III**	Introduction to computer graphics, basic applications - computer animation, visual simulation, AR and VR systems. Vector graphics, raster graphics - representation of image data. Basic graphics standards - GKS, PHIGS, OpenGL. Raster algorithms - Bresenham, anti-aliasing, HLHSR. Geometric modeling - curves and surfaces, 3D objects. Geometric transformations - translations, rotations, scaling, projection. Color modeling - color perception, CIE, RGB, HLS, HSV(B) color models, color space transformations. Lighting modeling - lighting models, shading algorithms, raytracing, radiosity. Texture Modeling - Defining, mapping, and filtering textures.
11.	**Software Quality Engineering III**	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
12.	**Cryptology III**	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
13.	**Mathematical Methods of Decision Support III**	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-making under uncertainty. Methods of determining the representation of sets of

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		irreparable decisions. Methods for determining "approximate sets of optimal solutions". Examples of modeling decision support processes.
14.	**Discrete Mathematics III**	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers. Break down the number into its components. Asymptotics. Creating functions. Asymptotic notations. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
15.	**Generative and aspective methods in manufacturing software III**	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
16.	**Numerical methods III**	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
17.	**Multi-Criteria Optimization Methods III**	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
18.	**Mathematical Modelling III**	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin, maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of indistinguishability. Lower and upper approximation of the set. Approximation accuracy. Optimal decisions with approximate data knowledge. Decision boards.

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		Deterministic and non-deterministic rules. Uncertain variables.
19.	**Modeling and verification of ICT networks III**	Basics of verification of ICT systems (ST) based on formal models: model verification, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-2, CPN Tools, UPPAAL.
20.	**Modeling Conflict Situations III**	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
21.	**Business Process Modeling, Simulation and Analysis III**	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
22.	**Software Reliability III**	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and programmatic methods of shaping reliability software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability indicators, finite error models, infinite error models. Models in the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1-1988, IEEE/ANSI Std 982.2-1988.
23.	**Reliability of Systems III**	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for

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		renewable facilities with zero renewal. Reliability of renewable facilities with non-zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of reliability structures. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
24.	**Optimization III**	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
25.	**Probabilistic III**	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.
26.	**Stochastic Processes III**	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
27.	**Image Recognition and Processing III**	Introduction to the issues of digital recognition and image processing. Basic problems related to digital image acquisition and how to solve them. Frequency methods in digital image processing. Basics of using transforms in digital image processing and analysis. Spatial methods in digital image processing. Improving the quality of images with the use of convolutional, ranking, logical filters - their advantages, disadvantages, ways of implementation. Introduction to digital image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Basic methods of image identification: classification in the space of features, structural method.
28.	**Neural networks and fuzzy logic III**	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
29.	**Smart radio networks**	Smart radio network concept. CRAHN ad-hoc networks. CR hardware and software architectures. Semantic context of CR. Problems of teaching in the CR system. Policies in the CR network. Dynamic spectrum management. Sensing and spectrum sharing. Collaboration and competition in CR networks. Security problems in CR. Standards for CR networks and CR solutions in NG (New Generations) networks
30.	**Stochastic Exploitation Models III**	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the

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		implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
31.	**Computer Simulation III**	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simulation systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
32.	**Database Systems III**	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
33.	**ICT systems III**	Route and link availability control in the LAN environment: LAN link availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol: the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IPSec protocol, MPLS-based VPNs.
34.	**Decision support systems III**	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
35.	**Artificial Intelligence III**	Paradigms of artificial intelligence and areas of its applications, limitations of artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search,

Lp.	Item Name	Curriculum content
		simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
36.	**Theoretical foundations of computer science III**	Algorithmic theory of information. Accuracy and correctness of algorithms. Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transformations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
37.	**Graph and Network Theory III**	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. A complex graph as a special type of graph. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms. Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
38.	**Project and Process Management III**	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of projects and processes, planning the usability and functionality of project processes, planning the reliability of project activities, planning of control and verification of results, project risk management.

Lp.	Item Name	Curriculum content
		Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the enterprise, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, management of communication in the project, methods and techniques of process improvement, models of process management development. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of the rhomboid model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
39.	**Complex Data Structures III**	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.
40.	**5G network application for military**	5G network technologies. 5G use cases and system concept. 5G Network Architecture. 5G architecture elements and functionalities/roles. Millimeter wave communications. Device-to-device (D2D) communications. The 5G radio-access technologies. Machine-type communications. Massive multiple-input multiple-output (MIMO) systems. 5G Network Miltary Gaps. Sensors and effectors. Military scenarios (use cases). 5G network Military Application and use cases: 5G network in Spectrum Situation Awareness application (workshop). 5G network Military Application and use cases: (own work/seminar/workshop with teacher support).
41.	**Advanced cryptanalysis tools**	Elliptic curves, hyperelliptic curves and the concept of a diviser. Attacks on elliptic curves using transfer methods. Improper and degenerate curve attacks: An example of a practical attack on TLS-ECDH. Index method on elliptic curves over extended and straight bodies. Quantum attacks: Shor's and Grover's algorithm. Algebraic attacks. Transformation of factorization, discrete logarithm, and algebraic attacks into the QUBO problem. Application of quantum annealing in cryptanalysis. Isogeny-based cryptography. Practical attacks on the post-quantum scheme of SIDH. Cryptanalysis of selected cryptological problems.
42.	**Probabilistic graph models: representation**	Basics – probabilistics, graphs, information theory, optimization; Bayesian lattices and directed graphs; Markow's networks and undirected graphs; local probabilistic models.

Lp.	Item Name	Curriculum content
43.	**Probabilistic graph models: the basics of inference**	Strict inference, elimination of variables; approximate inference: approximation with probability propagation, progressive sampling, Markov chains and Monte Carlo methods; inference algorithms, inference in state space models.
44.	**Probabilistic Graph Models: Inference Methods**	Information entropy; Transmitting confidence-rated messages; inference: variational, using Monte Carlo methods, using Markov chains.
45.	**Probabilistic graph models: parameter estimation**	Machine learning of graphical models; linear models; estimation of model parameters; models with incomplete data; Teach undirected models predictive models; Deep neural networks, Bayesian neural networks.
46.	**Probabilistic graph models and hybrid models**	Causality, complex decision-making model; models with hidden variables; statespace models; deep machine learning with graph models; decisions under uncertainty – selected algorithms for approximate inference and learning.
47.	**GNSS – Systems and signals" (GNSS)**	The state of the art of GNSS - the introduction to GNSS, the classification of systems, and areas of implementation of GNSS. The architecture of systems and elements – structures, description & characterization of physical processes, technical parameters, and areas of application. Signals in GNSS – classification, mathematical models of signals, propagation of signals, interferences of signals, methods of protection of signals. Modeling and simulation of systems and signals. Modeling and simulation of jamming and spoofing.
48.	**Multidimensional Data Processing (WDP)**	Basics of the theory of pattern recognition in data. Pattern definition, pattern classes, and the process of recognizing patterns in data. Pattern recognition techniques used. Division of data classification and grouping methods. Grouping criteria and methods. Threshold criteria (nearest and most distant neighbor). The distance of Euclid, Sebestyen, Mahalanobis, Hamming, Cannber and selected similarity functions. Grouping methods based on hierarchical grouping algorithms. Construction of dendrograms. Extraction of distinctive features using polynomial interpolation (Lagrange analysis).
49.	**Automated Battlefield Database Systems (SBD-ZPW)**	Basic terminology and characteristics of databases. Requirements for databases. Database technology, data models, data structures, data model operators, integrity constraints. Developer tools. Database management system (software, functionality). Database System Architecture (ANSI/SPARC). Database system users. Implementation technologies. Communication architecture. Division of database systems. Entity relationship model, relationship modeling, entity hierarchy. Transformation, entity transformation rules, relationship transformation rules. Standardization and its process and basic concepts. The first (1NF), second (2NF), third (3NF) and fourth (4NF) normal form. Concurrent data access, data loss after failure. ACID transaction properties, transaction state diagram, logical vs. physical transaction, transaction model and classification, transaction executions. Operational data structures in the MIP model JC3IEDM database. Replication, transformation and data exchange based on the DEM protocol. Databases in battlefield analytics

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering, geodesy and transport

Lp.	Item Name	Curriculum content
1.	Safety and reliability of building structures	Knowledge in the field of safety and reliability of building structures. Classifications and rules for shaping the load-bearing structures of buildings and the conditions for assessing their safety. Methods of description and distribution of random variables. Functions of reliability and damage intensity. Methodology for conducting reliability tests, risk assessment, the safety of building maintenance and their effectiveness.
2.	Dynamic interaction of building structures with a soil medium	Methods of formulating computational models of the dynamics of structural elements and systems as well as the soil foundation medium of the building. Determination of the physical characteristics of the soil medium under static and dynamic loads. Influence of the content of the phases on the parameters of the substrate.
3.	Environmental physics	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits. Types of light sources for lighting. Indoor and outdoor illumination, luminous flux, illuminance, luminous efficacy, light source spectrum, standard observer, objective determination of the source color.
4.	Modeling of thermal and humidity processes	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
5.	Identification of loads and structural systems	Identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of the initiating reactions of the supporting systems of objects, which are revealed by static or dynamic displacements or vibration frequencies.
6.	Investment process in the construction industry	Organization of construction investments, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
7.	Mechanics of road and airport runway soil foundations	Modeling of the soil as a single-phase or three-phase continuum depending on the type of soil (cohesive or no-cohesive). Stiffness and load carrying capacity of the ground as the problem of an elastic half-space. Dynamic effects generated by moving loads.
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
9.	Design methods for folding bridge structures	Construction of folding bridges with determination of their technical and operational parameters. Theory of Calculation of Folding Bridges Taking into Account Mounting Clearances for Objects in Static and Dynamic Systems.

Lp.	Item Name	Curriculum content
10.	Design methods of the experiment	The essence of experimental research. Resistance extensometry. Measurements and analysis of measurement errors. Organization of the measurement line. Experimental methods of testing materials in simple stress conditions - tensile, compression, shear, bend, torsion tests. Materials testing in complex stress states. Assessment of rheological properties of materials - creep and relaxation. Optical research methods in mechanics – elastooptics, optical, mesh and holographic interferometry.
11.	Modeling the behavior of elements and structures reinforced concrete	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
12.	Geometric and physical nonlinearities in mechanics Design	Deformations of flaccid structures and bodies with low rigidity, the use of geometric relationships with linear and nonlinear terms. Consequences of deformation in equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.
13.	Explosive effects on defensive structures	Physics of phenomena generated by explosion of explosive charges and fuel-air mixtures. Methods of determining the parameters of explosion loads. Types of mechanisms destroying elements and load-bearing structures of buildings.
14.	Scheduling and costing systems for construction works	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
15.	Engineering of building materials	Contemporary trends in the modification of building, construction and finishing materials. Technologies of preparation, implementation and optimal procedures for incorporating materials and products under building conditions. Structure and material considerations of composites used in construction. The role of additives and admixtures in buildings technologies.
16.	Cartographic methods of research	The use of maps to describe, analyze and scientifically learn phenomena, including cartometric research, mathematical and statistical analysis and methods of mathematical theory of information. Issues related to, among others, distribution analyses (potential maps, concentration analyses), dynamics of phenomena, as well as correlation methods and trend methods.
17.	Spatial data exploration	Review of exploratory data analysis methods with particular emphasis on geospatial data, including classification and grouping, reduction of the number of variables, and spatial pattern discovery. Classification using decision trees and the Byesian classifier, hierarchical grouping, and quality evaluation of classifiers and model validation.
18.	Data science in geospatial research	Advanced geospatial data processing, analysis, and modeling. Searching for trends and dependencies using exploratory data analysis techniques, machine learning and artificial intelligence, m.in.: real estate market, land cover changes, population distribution. The quality of the data and its impact on the effect of forecasting and modeling, as well as effective reporting and visualization of results.
19.	Advanced methods of implementation of studies photogrammetric	Problems of filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF. Fundamental problems of contemporary digital photogrammetry. Digital image acquisition systems – photogrammetric digital cameras and VHRS and Nano satellite systems. Remote sensing and photogrammetric methods of data acquisition. Modern photogrammetric technologies – their applications in the development of site and elevation maps, digital terrain model and orthophotomaps, as well as 3D spatial maps. Application of Computational Intelligence Algorithms in contemporary photogrammetric studies. Characteristics of new multi-image fitting methods. Methodology for developing dense point clouds from images.
20.	Programming in spatial information systems	The use of the programming environment, the concept of procedure, function and instructions for data processing. A way of accessing and processing spatial data directly using programming code. Libraries that enable spatial data processing in the .NET environment, the ability to automate the ArcGIS environment using Python.

Lp.	Item Name	Curriculum content
21.	Reference systems in geosciences	We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference. To be understood in context, when the motion of the Earth's crust is observed, it must be referenced. The global geodetic frame of reference is the fundamental basis for measuring worldwide processes and is crucial for its proper interpretation especially for climatic studies. A terrestrial reference frame provides a set of coordinates of some points located on the Earth's surface. It can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space. This rotation is assessed with respect to a frame tied to stellar objects, called a celestial reference frame. The Earth Orientation Parameters (EOPs) connect these two frames together. Nowadays, four main geodetic techniques are used to compute accurate coordinates: the GPS (Global Positioning System), VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite). They all use networks of stations located on sites covering the whole Earth. Modern realizations are of kinematic type, which means that they include station positions and velocities. They model secular Earth's crust changes that is why they can be used to compare observations from different epochs. The Ph.D. students will learn about advancements of the International Terrestrial Reference System (ITRS) which is a World spatial reference system co-rotating with the Earth in its diurnal motion in space for the geodetic, but also astronomical, and geophysical communities.
22.	Global Geodetic Observing System	Global Geodetic Observing System (GGOS) is the Observing System of the International Association of Geodesy (IAG). GGOS and its related research and services address the relevant science issues related to geodesy, geodynamics and geophysics in the 21st century, but also issues relevant to society, like global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea level estimations and ocean forecasting, or the space weather. The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS mission is to: (i) provide the observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, (ii) provide the global geodetic frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications, and (iii) benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built. Within this subject Ph.D. students will advance their understanding of the dynamic Earth system by quantifying our planet's changes in space and time and learn about the integration within the geodetic, geodynamic and geophysical communities at the highest level, in service to the technical community and society as a whole.
23.	Modern photogrammetric techniques	A modern approach to photogrammetric studies based on the use of the latest techniques of processing imagery obtained from various altitudes and the use of their geometric relationships in the field of situational and elevation measurement in areas including: development and updating of maps, feeding topographic databases, supporting the construction of 3D cadastre, as well as cooperation with mobile systems in the field of building virtual reality at various levels of detail.
24.	Selected numerical methods in geodesy	Practical use of numerical methods to solve scientific and technical problems (geodesy), ideas and concepts of numerical methods, numerical algorithms, programming elements - computational scripts. Use of selected tool libraries of scripting languages such as Matlab, Octave and Scilab.
25.	Methods of parallel data processing	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods and functions of the Parallel Computing and MATLAB Distributed Computing Server Toolbox modules.
26.	Mathematical foundations of digital image processing	Creating gradient and edge filter masks based on differential diagrams constructed using the finite difference method (FDM) and the finite element method (FEM) (convergence, agreement, order of precision, π- as the first form of differential approximation). Spectral properties of masks (matrices of the third and fifth order), including the spectral transfer function and its graphical presentation. The goodness of the mask is defined as the quotient of the spectral transfer function of the filter under study and the visual transfer function of the differential

Lp.	Item Name	Curriculum content
		transfer of the Laplace operator. Operations on masks (addition, subtraction, 45° rotation), determining the form of the differential operator related to the results of these transformations (Laplacian, bi-Laplacian, etc.). Filters that identify only corners (vertices). Bi-Laplacian mask vs. Harris corner detector.
27.	Numerical methods with linear algebra	Vector norm, matrix norm, induced norm. Norm 1, 2 and maximum. Matrix conditioning indicator. The use of linear algebra methods in numerical (differential) solving of mathematical physics problems (advection equation, diffusion, diffusion problem with advection). Convergence and stability of the differential method. Spectral transfer operator. π- a form of the first differential approximation. Numerical diffusion, creation. Analysis of selected differential schemes in terms of spectral properties – explicit, implicit, semi-implicit scheme, Crakn-Nicholson, Crank-Nicholson-Galerkin. Dissipation and dispersion in Lax-Wendroff and Beam-Warming schemes used in civil engineering and trance-sport.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

Lp.	Item Name	Curriculum content
1.	Structural studies by X-ray diffraction	Basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	Structural studies by scanning microscopy	Terms used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Preparation used in reflection and transmission electron microscopy. Selected by advanced microscopic methods (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of images and breakthroughs).
3.	Mechanical Properties Testing of Engineering Plastics	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	Physical basis of electro-optical effects in Liquid Crystals (CK). Selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals.
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	Study of materials, in particular materials for storing hydrogen in the solid phase, using: differential calorimetry, thermogravimetry and volumetric analyses. Types of equipment, principles of operation, calibration methods, good practices of use, advantages, disadvantages, possibilities and limitations. Basics of analysis of test results, correction of results and selection of test parameters to obtain the best results.
6.	Semiconductor materials for optoelectronic applications	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic semiconductors).
7.	Nano and ultra-crystalline construction materials	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	Nanoporous anodic aluminum oxide: synthesis, Design & Applications	Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.). Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electrochemical synthesis (temperature, voltage, time). The process of self-organization of the matrix pores into a hexagonal system. Soft anodization. Hard anodization. Pulsed anodization. Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods). Applications of anodic aluminum oxide matrix (biosensors, filters, optoelectronic components, tissue engineering, etc.). New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	Non-telecommunications	Interference (phase) fiber optic sensor technology. Terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the definition of the role of the transducer as well as optical

Lp.	Item Name	Curriculum content
	applications of fiber optics	and electronic signal processing. Methods of building sensors with a point and a distributed detection field. Multiplication of point sensors.
10.	Measurements of machine and equipment parts with using coordinate measuring techniques	Use coordinate measuring techniques and tactile profilometry at various stages of the production process. Metrological properties of coordinate measuring machines and tactile profilometers Programming of a multi-sensor measuring machine to carry out measurements as part of the final acceptance of machine parts and equipment manufactured in mass production conditions.
11.	Experiment planning and data analysis with using Origin and Statistica	The use of computer programs to plan an experiment. Statistical methods. Origin and Statistica's capabilities for experiment planning and data analysis.
12.	Basic properties of liquid crystals	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	Keysight Vee and Lab View in Control and data processing	Basics of programming in LabView, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops (for loop, while), selection structures, feedback, etc. How to use objects of various types (numeric, string, bool), including in the form of matrices and clusters. Methods of data processing and transfer. Creating a program algorithm to control a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Basics of programming in Keysight Vee, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops, selection structures, conditional statements, etc. A way of using objects of various types, including matrices and complex variables. Basic methods of data processing and transfer. Cooperation Keysight Vee – MS Excel. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	Designing technological processes for incremental Direct Deposition methods	Design of elements of machine and equipment parts using solid and surface modeling. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological process design - production of the target production series
15.	Dielectric spectroscopy	Dielectric spectroscopy (impedance spectroscopy/radio range spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics for the analysis of the properties of materials used in electronics. Electrical phenomena at the atomic, molecular, and macroscopic (medium) levels. Theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. Parasitic effects in impedance measurements. Research equipment (impedance analyzers), experiment and analysis of experimental data in the context of the properties of various materials.
16.	Structural Determinants of Material Properties	Terminology, methodology, critical reception of external data, critical evaluation of the results of solving scientific problems in the area of materials and technology. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions.
17.	Modern methods of material characterization	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.
18.	Contemporary information imaging systems and directions of their development	Modern imaging systems for direct observation: liquid crystal, organic LEDs, microleds, flexible and roll-up displays. Discussion of the effects and materials used. The level of solutions achieved, limitations resulting from the physics of effects, material possibilities, available technology. Projection systems used effects, solutions ranging from cinema systems through didactic systems to micro-

Lp.	Item Name	Curriculum content
		projectors. Directions of development of displays and projection systems. Particular emphasis will be placed on combining knowledge about the physical effects used in the construction of displays, new materials (including nano-structures used in LCDs, OLEDs and microLEDs), and the possibilities of modern technology with compliance with environmental protection requirements.
19.	High-energy ball milling and mechanical synthesis	Issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. Types of ball mills, the principle of their operation, capabilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.
20.	Advanced materials for hydrogen storage	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity hydrogen storage materials. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
21.	Basics of plasmonics and metamaterials	Basic definitions of plasmonics and metamaterials. Physical basics, interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces. Technological conditions for the implementation of metamaterial one-, two- and three-dimensional structures. Physical and technological requirements and limitations for different types of metamaterials, as well as the use of classical technologies for the production of nano- and metamaterials. Methods for simulation of the properties of selected metamaterial and plasmonic structures and methods for characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. Application of metamaterial structures in photonic devices and prospects for the development of nano- and metamaterials with particular emphasis on military applications.
22.	Optoelectronic Imaging and Information Processing Techniques	Colour vision, perception of black-and-white and colour information and the human-display-imaging interdependence, display requirements and ergonomics of various types of imagery. Physical and theoretical basis of the effects used in displays and their determinants. Active displays - fluorescent, plasma, electroluminescent, construction, characteristic parameters, purpose and passive displays - liquid crystal, electrophoretic, structure, parameters and conditions of applications. Segmented and multiplex liquid crystal displays as well as active matrix controlled liquid crystal displays. Projection systems, large-format displays, purpose, advantages, disadvantages. Organic and inorganic materials for displays and characteristics of their properties and elements of display manufacturing technology as well as characteristics of technological processes, methods of control and evaluation of display performance parameters. Methods of three-dimensional imagery, methods of implementation and application, teleimmersion.
23.	Selected Materials and Functional Structures for Photonic Applications	Properties and applications of such materials and structures as: optical glass and polymer substrates for the construction of electro-optical transducers, oxide and organic functional layers used as anti-reflective layers, bandstop and edge filters, transparent conductive organic and inorganic layers, nanomaterials for organic applications, photonic polymers and liquid crystals, including composite structures. Construction, construction and operation of selected photonic elements, made on the basis of, among others. the above-mentioned functional materials; spatial light modulator, dynamic wave plates, dynamic elements of diffraction optics (diffraction gratings), optical vortices, microlasers based on self-organizing structures, Kerr and Pockels cells, optical materials and elements for spatial imaging and others.
24.	Computer Image Analysis in Materials Science	Basics of stereology, including basic assumptions and stereological implementations. Detection methods and binarization procedures necessary for quantitative image analysis. Fundamentals of image acquisition and processing (m.in. morphological transformations, logical and arithmetic operations). Procedures carried out during computer image analysis in the study of real engineering materials.
25.	Additive manufacturing of functional materials	Practical aspects of additive manufacturing of functional metallic materials using LMD/LENS laser technology. Influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of functional materials.
26.	Methods for amplifying	Basic types of broadband semiconductors. Properties of luminescent broadband

Lp.	Item Name	Curriculum content
	light emission from broadband semiconductor nanostructures	semiconductors on specific examples (e.g. GaN, ZnO, SnO2). Methods of synthesis of nanostructures. Modulation of optical properties of nanostructures at the synthesis stage. Post-synthetic methods of luminescence enhancement. Intentional doping of broadband semiconductors. The phenomenon of charge and energy transfer. The phenomenon of surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR). Plasmonic light gain from semiconductor nanostructures – basic criteria for coupling SPR or LSPR to the frequency of optical transitions in semiconductors at the metal/semiconductor interface.
27.	Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals	Basic knowledge of the production of porous anodic aluminum oxide (AAO). Parameters of electrochemical synthesis. The phenomenon of constructive and destructive interference. Single-layer and multi-layer interference. Features of an ideal anti-reflection coating. Anti-reflective coatings with graded refractive index. Microstructure of the moth eye. Surface wettability. High-energy vs. low-energy surfaces. Hysteresis of the contact angle. Wetting textured surfaces: Wenzel model vs. Cassie-Baxter model. General characteristics of 1D, 2D and 3D photonic crystals. Structural coloration. Inspirations drawn from nature, or what is biomimetics. Multi-stage electrochemical synthesis of AAO with conical pore shapes. Electrochemical production of 1D crystals by pulsed method. Design of voltage or current pulse sequences, taking into account processes limited by diffusion and the speed of ion transport through the barrier layer. Control of electrochemical synthesis parameters to obtain the desired photonic properties of AAO-based photonic crystals.
28.	Modeling of semiconductor devices.	The genesis of transport equations derived on the basis of the principles of behavior and postulates of thermodynamics of irreversible processes. Generation-recombination mechanisms responsible for the magnitude of charge carrier concentration. Contribution of cross-band processes and SHR mechanisms involving point defects, dislocations and surface states. Process modeling and determination of cross-sections. Mechanism of interband absorption of radiation. Construction of iterative diagrams enabling numerical solving of a system of transport equations. Record on the numeric grid. Problems related to numerical solving of nonlinear equations. He will be able to write a fragment of the program as a task to pass the subject. This fragment can be implemented into my program in order to design a specific device or to study the physical parameters of the structure.
29.	High-entropy alloys – synthesis, structure, research and properties	The latest group of materials – the so-called high-entropy alloys. Theoretical aspects of their formation and stability, properties, structure, synthesis methods and heat treatment. Practical attempts to synthesize and study the properties of alloys from this group.
30.	Additive manufacturing of phased alloys intermetallic	Specific aspects related to the additive manufacturing of alloys based on intermetallic phases (in particular FeAl). The influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of these materials.
31.	Combinatorial Materials Manufacturing and Testing Engineering	Possibilities of using DED laser additive techniques for combinatorial search for new engineering materials. As part of the course, attempts will be made to synthesize both continuous and discrete alloy libraries and the possibility of their rapid study.
32.	Reactive mechanical grinding as a method for the synthesis of modern hydrogen storage materials in the solid phase.	Synthesis of solid-phase hydrogen storage materials using reactive hydrogen grinding in ball mills. Attempts at the synthesis of selected metal hydrides and complex hydrides and studies of the influence of synthesis conditions on its result and the properties of the produced material.
33.	Additive techniques with elements of reverse engineering	Devices used in reverse engineering. Editing and processing of point clouds and generation of STL files, taking into account technological specifics. Preparation for 3D printing (model positioning, material selection, degree of infill, division into layers, source code generation). Multi-variant production of models with complex geometry using FDM and SLA techniques. "Post-processing" and assessment of the quality of the obtained printouts using a 3D scanner and a micro-computed tomography.
34.	Overview of additive techniques used in	The idea, technical solutions and development trends of 3D printing. Overview of additive methods used in strategic industries – material, technological and

Lp.	Item Name	Curriculum content
	modern technology	economic conditions. Specifics of the processing of high-strength thermoplastics used in aviation and medicine – devices, technological parameters of 3D printing. Evaluation of the geometric and metallurgical quality of sample parts of printed machines using various additive techniques. Additive technologies and Industry 4.0.
35.	Selected issues in 3D printing	Analysis of the possibility of manufacturing structural elements using Rapid Manufacturing techniques. Specificity of processing advanced construction materials using laser additive forming methods. Material tests and assessment of geometric quality of printouts. Traditional vs. laser methods of regeneration of machine and equipment parts. Analysis of the possibility of reconstructing the operating indicators of machine and equipment parts using the semi-industrial LENS system – multi-criteria quality assessment.
36.	Researcher's workshop 1 – tools for writing scientific texts	The course introduces the doctoral student to issues related to the basic methods of creating texts describing the results of research work, including advanced use of the functions of the following programs: MS Word, LATEX, ENDNOTE, MENDELEY and practical ways of creating drawings, tables and citations. In addition, doctoral students are familiarized with the methodology of selecting the right journal and practical tips when sending manuscripts for publication in prestigious journals.
37.	Researcher's workshop 2 – writing scientific articles	The course introduces the doctoral student to issues related to the basic methods of designing the content of scientific articles, the vocabulary used, methods of graphic processing of results and the use of software helpful in the creation of scientific texts. In addition, the methods of literature analysis, the ethics of creating scientific texts and the selection of authors, the basis of the methodology for processing the results, as well as the possibilities of using software and services for linguistically correcting scientific texts will be presented.
38.	Researcher's Workshop 3 – Writing Scientific Articles	The subject introduces the doctoral student to issues related to the estimation of measurement uncertainty in scientific papers. The issues raised during the classes are focused on learning practical methods of determining uncertainty in real measurements. Theoretical aspects, i.e. the mathematical apparatus used in estimating uncertainty, is reduced to the necessary minimum. Part of the classes is intended to solve the issues reported by doctoral students.
39.	Quantum mechanics in examples	The course aims to solve in detail and analyze the most important examples describing the behavior of particles in the microworld in the language of quantum mechanics. After the introduction to wave mechanics, the following examples will be analyzed: free particle; transmission (reflection) through the potential threshold; transmission (reflection) through the potential barrier (tunnel effect); an infinite pit of potential; a finite pit of potential; harmonic oscillator; the Krönig-Penney model; solving the problem of the Coulomb potential.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

Lp.	Item Name	Curriculum content
1.	Numerical Analyses in Load-Bearing Structures	Theoretical foundations of numerical methods of analysis of load-bearing structures including multi-stage analyses, strategy of computer FEM simulation of two- and three-dimensional problems in the field of mechanics and strength of materials and methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphics preprocessors. Construction of 2D and 3D models for analysis in the field of selected engineering issues, performance of calculations with attention to the selection of optimal analysis parameters and assessment of the correctness of calculation results using analytical methods and available results of experimental tests, on the example of elements and components of vehicles, special and load-bearing structures.
2.	Autonomy of mobile robots	Introduction, definitions, components of the construction of mobile robots. Wheeled robot drive systems. Navigation and self-location of robots. Navigation with the use of markers. Odometry, methods to improve self-localization results. Determining the position of the robot based on the map. Methods of planning the path of a mobile robot. Local planning, probabilistic methods. Tasks, construction, architecture of control systems Vision systems in mobile robotics. Walking robots. Applications of autonomous mobile robots.
3.	Non-destructive testing of aircraft	Types of defects, defects and damage that threaten the safety of operation of technical facilities. Non-destructive testing methods – physical basis. Visual and penetrative methods. Ultrasound method. Acoustic methods. Eddy current method. Thermographic method. X-ray method. Shearograps and DSight. Non-destructive testing methods – advantages, disadvantages and limitations in use. Non-destructive testing certification.
4.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of a human body model and experimental research. Calculating the risk of injury to the head, torso and thighs. Injury risk prediction models.
5.	Construction and operation of industrial robots	Construction and operation principle of industrial robots. Principles of robotization of production lines. Environments and languages for programming industrial robots
6.	Digital signal processing	Mathematical models of deterministic signals. Advanced signal sampling techniques. Selected problems of analysis of discrete signals in the time and frequency domain. Frequency resolution of digital spectral analysis algorithms. Fast weave algorithm. Selected specialized implementations of digital filters. Basics of digital filter design. Decimation and interpolation of digital signals. Digital signal spectrum conversion. Direct Digital Signal Generation Method (DDS). Program receiver.
7.	Dynamics of mechatronic system design	Issues of modeling mechatronic systems. Elements of motion and vibration analysis of linear systems with single and multiple degrees of freedom. Elements of motion analysis of nonlinear mechatronic systems. Stability testing of linear and nonlinear mechatronic systems. Self-excited vibrations. Methods of measuring vibrations of mechatronic systems.
8.	Dynamics of car movement	Modeling the movement of the car. Modeling of movement on hard, snowy and deformable surfaces. Analysis of the dynamics of rectilinear and curvilinear motion. Steerability and stability. Overcoming terrain obstacles. Wheeled and tracked chassis. Modeling the process of a car crashing into an obstacle. Analysis of vibrations and driving comfort.
9.	Dynamics and modeling of hydrostatic systems	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis and its description. Modeling of hydrostatic drive assemblies, subassemblies, elements and systems. Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
10.	Dynamics of multi-member systems	Theoretical foundations of numerical methods of analysis with the use of rigid bodies and the strategy of computer simulation of multibodies with the use of

Lp.	Item Name	Curriculum content
		various algorithms for the formulation of equations of motion and their integration. Overview of multibody analysis software environments and examples of mechanical engineering solutions. Methods of modeling mechanical structures with rigid solids in planar and spatial systems. Construction of planar and spatial models with the use of various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected issues of mechanical engineering. Multivariant numerical analyses with attention to the selection of optimal calculation parameters and the assessment of the correctness of the obtained results using analytical and experimental methods.
11.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
12.	Computer-aided operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
13.	Shaping a safe car body	Body construction - shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
14.	Composite materials in mechanical engineering	Definition and classification of composite materials. Strength and performance properties of composite materials. Technologies for the production of composite materials. Research used in the experimental analysis of mechanical properties of composites. Joining composite materials. Metal-composite joints. Exploitation of composite materials. Repairs of composite structures.
15.	Finite Element Method	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
16.	Methods of analysis of numerical experimental research results	Selected deterministic and stochastic examples in the research methodology allowing the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
17.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
18.	Experimental methods for investigating the thermophysical properties of solids	Thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
19.	Methods and techniques for testing the mechanical properties of materials	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring deformations during strength tests. Methods of testing the mechanical properties of materials under shock loading conditions. (Hopkinson test, Taylor test, ring test).
20.	Numerical Methods in Engineering Applications	Basic concepts related to numerical calculations, sources of errors. Interpolation and approximation. Differentiation and quadrature. Systems of linear equations. Algebraic eigenproblem. Methods of solving ordinary differential equations. The linear problem of least squares. Fourier analysis. Optimization elements. Information about other areas of numerical analysis (partial differential equations,

Lp.	Item Name	Curriculum content
		stochastic methods, etc.).
21.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
22.	Methods for designing and optimizing aircraft structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission modeling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
23.	Constitutive Models of Materials in FEM Analysis	Mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. Experimental studies to determine the parameters of models. Numerical analyses using learned material models.
24.	Modelling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software
25.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
26.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
27.	Parametric modeling and structural optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
28.	Flow modeling	Methods of computer modeling of flow processes in basic and applied problems of fluid motion dynamics. Simulation methods for researching streamlined issues. Basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver. Modeling of flow turbulence, including averaged Navier-Stokes equations, turbulent stress tensor, turbulence modeling capabilities and problems. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES). Mapping of complex simulation study objects, construction and execution of basic operations on computational grids, analysis of the reliability and accuracy of numerical modeling results.
29.	Modeling machine motion	General principles of modeling mechanical systems. hydrostatic, electromechanical. Deterministic and random processes. Construction of simulation models. Identification of model parameters and their validation. Characteristics of basic dynamic members. Basics of dynamics of systems with variable mass.
30.	Modeling composite structures	The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.

Lp.	Item Name	Curriculum content
31.	Modeling of the Contact Phenomenon in Structural Mechanics	General division of contact phenomena. Mathematical foundations of the description and solution of the problem of contact. Algorithms for defining and solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
32.	Modeling and research of the processes of cooperation between the wheel and the road	Issues of modeling and testing the processes of cooperation between the wheel and the road to the extent necessary to model the dynamics of vehicle motion (selected mathematical models, methods and techniques of testing tire wheels on a drum stand and with the use of a test trailer).
33.	Modeling of car traffic and controls	Review of vehicle motion dynamics models and models describing the driver-vehicle-road system (models of lateral dynamics of the car in various control configurations).
34.	Modern technologies for bonding structural materials	Friction stir welding (FSW), laser beam welding (LBW), areas of application and strength properties of the cohesive joints obtained. Influence of bonding processes on the microstructure of selected construction materials. Heat and mechanical treatment of FSW and LBW cohesive joints.
35.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
36.	Renewable energy sources	The importance of energy in the development of modern civilization. Modern fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
37.	CAE Engineering Software	An overview of CAE engineering support systems with an indication of their purpose and the possibility of using them in structural analyses. Preparation of numerical models for calculations in the static and dynamic range. Running calculations and presenting and processing the results obtained.
38.	Experiment planning and optimization of mechanical objects	Introduction to planning an experiment. Measurement errors and uncertainties. Characteristics of random variables. Statistical hypotheses and their verification. Correlation and regression analysis. Plan your experiment. Two-level plans. Three-level plans. Multi-level plans. Simplex plans for analysis composition – property. Criteria for the optimality of plans. Optimization of Extreme Machine Technology of Statistical Functions and Their Limitations. Methods of determining the extremum of statistical functions. Examples of experiment optimization in mechanical engineering.
39.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Safety in the movement of autonomous vehicles. Statistics of road accidents and their interpretation.
40.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
41.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.
42.	Fundamentals of Mechanics of Continuous Media	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.
43.	LabVIEW environment in experimental research	The process of creating programs in the LABVIEW environment with the use of control and measurement equipment (myRIO, sbRIO, DAQmx). Data types in LABVIEW. Complex data types in LABVIEW, Communication with measuring devices in LABVIEW. Analysis of measurement results.

Lp.	Item Name	Curriculum content
44.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.
45.	Programming of control systems for unmanned working machines and robots	Introduction to the UML standard. Build relational schemas and use case schemas. Creation of control algorithms. Introduction to programming, programming devices for hydrotronic applications. Design a feedback loop. Implementation of feedback loops in control systems.
46.	Mechatronic sensors	Mathematical models of mechatronic sensors. General principles of mechatronic sensors. Methods of measurement, errors and methods of calibration of sensors.
47.	Condition monitoring systems	Sensors used in condition monitoring. Resistance strain gauge. Fiber optic sensors. Crack sensors. Data transmission. Recording and analysis of measurement data. Inference. Coupling of condition monitoring systems with the operating system and the operation system.
48.	Aircraft Operation Systems	Principles of operation and repair of military aircraft in the Republic of Poland. Harmonized European Military Airworthiness Regulations (EMAR). European Airworthiness Regulations (PART). The role of EASA and the Civil Aviation Authority in supervising the operation of aircraft. Bulletins and other documents regulating the operation.
49.	Control systems in mechanical engineering	Advanced control systems for mobile machines. Machine control system functions. Types of control systems. Development trends of sensors used in mobile machines. Vision and lidar locating and navigation systems. Satellite systems in machine control Centralized and distributed control. Intelligent communication networks. PLC control. Fuzzy logic in machine control
50.	Technologies for the production and processing of composite materials	Composites, ways of defining them, types of components that make them up, the most important methods of their production and processing, the importance of this class of materials in mechanical engineering. The structure of modern composite materials depending on the method of production and the treatment used, e.g. heat, thermo-plastic. Manufacture of ceramic matrix composites and multilayer metallic composites and achievements in the use of composites.
51.	Selected solutions in the field of automotive technology and car motion	Problems of the development of automotive technology and road traffic. Concepts of intelligent transport systems. Selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs, lighting systems). Driver assistance systems. Self-driving cars.
52.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
53.	Thermomechanics of materials and studies of thermophysical properties	Phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and presentation of selected issues of statistical description of these phenomena to explain the nature of thermo-physical properties. Heat transfer phenomena in materials and material structures. Material properties vs. resultant and apparent properties of material structures. Methodology of testing thermo-physical properties. Thermal Analysis Methods. Methods for determining specific heat, thermal conductivity, thermal diffusivity, thermal expansion of materials and material structures.
54.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.
55.	Durability of aircraft structures	Methods for determining and testing aircraft durability. Concepts of aircraft operation, factors limiting the durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in

Lp.	Item Name	Curriculum content
		aircraft operation. Corrosion of aircraft.
56.	Introduction to the equations of mathematical physics	Formulation of mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. General principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics. The method of reducing borderline issues to a dimensionless form is discussed. Formulation of mathematical models based on mathematical physics equations.
57.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
58.	Modern test methods for internal combustion engines and vehicles	Identification of the purpose of research. Selection of the test method. Validation of research methods and procedures. Approval test procedure. Selected methods of homologation tests, measuring equipment. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty Analysis and presentation of research results. Calibration of measurement systems. Practical implementation of selected research methods.
59.	Selected methods and techniques of temperature measurement	Theoretical basics of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. Types of thermometers: liquid, thermoelectric, resistive, thermistor, quartz, bimetallic, radiation, fiber optic and thermal imaging cameras. Statistical processing of measurement results
60.	Selected problems of rocket technology	Mathematical models of physical processes related to the dynamics of rocket motion. General rules for building rockets. Construction of rocket compartments with mathematical models. Computer simulation and visualization of the rocket flight path. Overloading of rockets on the flight path.
61.	Selected issues of waste gas treatment from motor vehicles	The impact of the automotive industry is influenced by the natural environment. Characterization of harmful substances. Systems and methods of motor vehicle waste gas treatment. Development tendencies in flue gas cleaning methods. Test methods and equipment for testing waste gases from internal combustion engines and vehicles. Studies on the influence of the operating condition of an internal combustion engine on the emissions of individual exhaust components and the granulometric composition of particulate matter.
62.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	Simulation tasks. Selection of the simulation method. Selected models of the work cycle of an internal combustion engine. Workflow simulation software. Procedure for simulating selected routings. Analysis and presentation of simulation results. Evaluation of simulation results. Simulation of selected working processes of internal combustion engines.
63.	Selected issues of modern programming - introduction to modern programming languages.	Introduction to programming using high-level languages. The issue of structural and object-oriented programming. Introduction to Python with basic libraries and the PyCharm environment. Creating console programs using Python. Introduction to creating GUI programs.
64.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Application of the principles of fatigue strength of materials and fracture mechanics. Fatigue test methodologies and fatigue testing equipment. Crack development due to cyclic loads. Fatigue crack growth characteristics. Methods for evaluating the strength of cracked components
65.	Advanced methods of manufacturing products from sintered powders	Manufacturing processes of machine parts using modern methods of manufacturing engineering, including powder metallurgy.
66.	Advanced ballistics, modeling, and simulation	Development trends in the field of solid propellants and propellant systems (theoretical basis for modeling the operation of atypical propellant systems from the point of view of internal ballistics). Outflow of powder gases from the barrel during firing and their flow through the muzzle brake (description of the phenomena occurring during the outflow of gunpowder gases from the barrel during firing - transitional ballistics). Geometrical, mass-inertial and aerodynamic

Lp.	Item Name	Curriculum content
		characteristics of missiles and rockets (theoretical basis for modeling the motion of flying objects from the point of view of external ballistics). Modeling of the impact impact of objects (theoretical foundations for analytical and numerical modeling of phenomena that are the domain of final ballistics).
67.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
68.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
69.	Advanced measurement systems	Structure and organization of computer-controlled measurement systems and with procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. Programming basics and how to use virtual instruments to collect, collect and process measurement data.
70.	Advanced Materials Testing Methods	Methods of testing materials, possibilities and limitations of various test methods based on the use of specialized equipment. Modern electron microscopy, confocal microscopy and X-ray microanalysis (qualitative and quantitative) and their practical application in mechanical engineering. Methods for investigating the macro- and microstructure of metals, their alloys and ceramic materials, and interpreting the test results obtained by various materials testing methods. Topographic contrast and its use for fractography studies, evaluation of changes in the microstructure of materials as a result of treatments, studies of powders and thin surface films. Microanalysis of phases and inclusions in materials research. Testing of material heterogeneity. Trace analysis of elements. Light microscopy in materials research. Metallography. Image analysis. Electron beam and its properties. Electron diffraction. Structure of a scanning and transmission electron microscope.
71.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
72.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
73.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	Issues related to wave propagation (elastic, plastic). Mathematical description of the phenomenon of mechanical wave propagation. Boundary conditions. Methods to solve the presented issue. Numerical analysis of wave propagation.
74.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force. Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
75.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials. Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.
76.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations -

Lp.	Item Name	Curriculum content
		condition index. Gaussian method of numerical solving of a system of linear equations. Direct methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Methods of numerical solving of ordinary differential equations.
77.	Electromagnetic field theory	Maxwell's equations; Differential form of Maxwell's equations in material media; Maxwell's equations for harmonically variable fields; Integral form of Maxwell's equations. Electromagnetic waves in an ideal dielectric; TEM type flat wave; Wave impedance and specific impedance. Electromagnetic waves in a lossy medium. Boundary conditions and energy relationships in the electromagnetic field. Power balance in the electromagnetic field in real and complex description. A real, complex and time-average Poynting vector. Wave incident obliquely on the dielectric-dielectric interface; Fresnel formulas for a plane wave falling obliquely on the boundary of two dielectric media. Reflectivity and power transmission. A wave incident perpendicularly at the dielectric-dielectric interface. Determination of reflection coefficients and power transmission for a plane wave incident perpendicularly on the boundary of two dielectric media. Electromagnetic waves in waveguides. Wave Mods. Potentials in electrodynamics and radiation from current sources; Vector and scalar potential. Delayed electromagnetic potentials. Potentials generated by localized sources. Hertz's Dipole.
78.	Quantum mechanics	Wave function and Schrödinger equation. Probabilistic interpretation of the wave function. Probability current density. Expected value. Separation of the wave equation. Quantum Mechanics Formalism; N-dimensional vector space; Space base; Scalar product; Hilbert space; Orthogonality of vectors and systems. Orthonormal bases; Linear operators; Operator equations; Matrix representation of an operator; Hermitian and unitary operators; Dirac notation. Selected solutions of the Schrödinger equation in 1D; A quantum particle in an infinite potential well. A free quantum particle. Uncertainty of Observables - Heisenberg Uncertainty Principles. Eigenvalues and eigenfunctions of a quantum harmonic oscillator. Creation and annihilation operators. Separation of the Schrödinger equation in 3D. Quantum particle in a spherical potential well in 3D. Values and eigenfunctions of the angular momentum operator. The spin theory of the electron. - Pauli matrices. Mutual uncertainty of spin components. Entangled states and non-locality. - The concept of entangled states and qubit. Their role in new quantum technologies.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

Lp.	Item Name	Curriculum content
1.	Analysis of Chemical Warfare Agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and technology of liquid crystal materials	Molecular structure, structures and textures of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and technology of high-energy materials	Current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels: structural determinants of the stability and sensitivity of explosive compounds; design, fabrication and characterization of nanostructured explosive mixtures; principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; New ways to craft explosive compositions and form them into charges. design, manufacture and characterization of thermobaric explosives; design, synthesis and explosive properties of complex compounds; design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids as well as new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Chemical Foundations of Environmental Pollution	Basics of ecology. Man and the environment. Natural resources and ecological factors: temperature, radiation, air, water and soil. Humanity in the face of global challenges. The paradigm of sustainable development. Principles of green chemistry. Air pollution (acid jet, ozone depletion, greenhouse effect, London and Los Angeles smog). Sources of water pollution (municipal, industrial and agricultural pollution). The most important pollutants found in sewage. Pollution of seawater. Water treatment. Soil pollution. Types of harmful effects of human activity on soil: geomechanical, hydrological and chemical transformations, physical and biological degradation. Heavy metals, their characteristics, sources and impact on the environment and human health. Characteristics of cleaning and washing agents (soaps, detergents). Negative effects of using cleaning and washing agents. Organochlorine compounds in the environment (chlorophenols, polychlorinated biphenyls, dioxins). Pesticides. Classification of pesticides and their properties. Chemical structure of pesticides. Pesticide forms. Benefits and problems of pesticide use. Building materials (paints, adhesives, asbestos, products containing formaldehyde, oils) and their impact on the environment and human health. Volatile organic compounds (VOCs). VOC sources. Harmful effects of VOCs in the stratosphere. Pharmaceuticals and personal protective equipment in water. Classification, sources of origin, occurrence and environmental impact of drug residues. Food chemistry. Classification and characteristics of food additives (preservatives, improvers, antioxidants, flavor enhancers, sweeteners, dyes). Dietary supplements.
5.	Physics and chemistry of carbon materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and bioactivity of carbon materials. Prospects for the development of new carbon

Lp.	Item Name	Curriculum content
		structures and their applications.
6.	Physicochemical aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
7.	History of chemistry	Synthesis of elements in the universe, first observations and chemical achievements of antiquity (alchemy). History of chemical discoveries in the world: physical chemistry, analytical, chemical analysis, organic synthesis, food chemistry. Achievements of chemistry after 1661 (R. Boyl). Development of separation techniques and analysis and their impact on the development of views on chemistry and the structure of chemical compounds. Evolution of nomenclature and symbols of elements and chemical compounds. History of the periodic table, kinetic and thermodynamic studies. The development of chemistry and organic synthesis in the twentieth century and its impact on the emergence of molecular biology.
8.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
9.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
10.	Spectroscopic methods	Expanding the knowledge on spectroscopic methods for PhD students in the discipline of chemical sciences. Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Modern spectroscopic methods.
11.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Adsorption of nitrogen and argon as a complete method for determining the specific surface area, porosity and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and investigation of adsorption properties of graphene composite materials. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
12.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials

Lp.	Item Name	Curriculum content
13.	Signal Processing in Analytical Chemistry	Basic methods of processing the analytical signal. Spectra obtained from measuring instruments used in analytics. Big data processing. Multivariate data obtained from combined measurement techniques. Search for analytical information contained in large data sets. Elements of chemometrics. Principal components method. Similarity analysis. Presentation of measurement data in scientific publications.
14.	Synthesis of liquid crystals	Introduction to liquid crystals, structure and anisotropic properties. Applications of liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Superfluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
15.	Introduction to Spectroscopy	Basic knowledge of spectroscopic methods for PhDs in disciplines other than chemical sciences. Two versions of the item are possible. Standard version: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Mass spectrometry (MS). Individual version in accordance with the interests of the PhD student, extending selected spectroscopic methods from the given group of methods: Electron spectroscopy (UV-Vis). Vibrational spectroscopy (IR and Raman). Oscillation-rotational and rotational spectroscopy. One-dimensional and two-dimensional nuclear magnetic resonance (NMR) spectroscopy. Circular dichroism spectroscopy (ECD and VCD). Mass spectrometry (MS).
16.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
17.	Advanced pyrotechnics	The latest solutions used in military and civilian pyrotechnics. Currently used reducers, oxidants, binders and modifiers. Pyrotechnic applications of high-nitrogen compounds. Modern compositions of curtain smokes active in the infrared range. Modern multi-base solid rocket fuels. Solutions used in airbag inflators. Prospective applications of pyrotechnic mixtures in medicine. Basic algorithms used in modeling combustion processes and analytical optimization of the composition of pyrotechnic compositions.
18.	The use of gas chromatography in research Physicochemical	The essence of interactions in chromatography. Mechanisms of chromatographing test substances. Basic chromatographic quantities. State functions – methods of calculation and interpretation. Study of the physical transformations of pure substances. Phase stability and phase transitions. Study of surface properties and basic surface phenomena. Methods of surface determination and analysis.
19.	Polymer chemistry	Polymers obtained in the process of polychain reaction. Condensation polymers, polyadducts. Inorganic-organic polymers. Polymers of natural origin. Special-purpose polymers.
20.	Modeling and simulation computer programs in chemistry	Fundamentals of Computational Chemistry: Computational Assumptions and Methods. CHEMCAD program organization and basics of use. Application of CHEMCAD in chemical technology and materials engineering. Implementation of a project in the field of chemical technology using the CHEMCAD system. Organization of the SCIGRESS program and basics of use. Optimization of geometry and calculation of physicochemical properties of molecules. Modeling of chemical reactions in the gas phase and solution. Modeling of spectroscopic properties of molecules.

Annex VI.7

to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security sciences

No.	Item Name	Curriculum content
1.	Social research in the sciences Safety	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Non-reactive methods. Desk *research*
2.	Statistical methods in research Social	Population and sample. Statistical features. Measurement scales. Random variables. Normal distribution. Characteristics of qualitative and quantitative characteristics. Nonparametric estimation. Parametric estimation (point and interval). Verification of statistical hypotheses. Diagram of the materiality test. Testing the normality of the distribution. Problems of analysis of the interdependence of phenomena. The research process in the social sciences and the typical structure of scientific work. The course of data collection, analysis and evaluation.
3.	Risk management in security	Risk concept and risk management process. The concept of risk and risk management. Development of the risk management field. Risk management process. Risk measures. Types of risk in the security sector. Risk measurement in public sector entities. Risk measurement in the context of ensuring system continuity.
4.	Management system designs Security	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
5.	Safety Systems Engineering	The place of systems security theory in the family of sciences. Basic concepts of system security (system status, description of system security-related states, system security indicators). Principles of mathematical modeling of system security. Component and subsystem safety. Systems security models. Systems security research. Analysis of system security. Control of safety, systems.
6.	Propedeutyka Security	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies are the "old" and "new" wars in the interpretations of realism and constructivism.
7.	Management strategies and concepts Security state	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal functional factors and ways of defining security in doctrines and strategies (comparative analysis).
8.	Management Crisis in administration Public	Contemporary concepts of crisis management (the concept of vulnerability, the concept of resilience, the concept of adaptation). The subject of crisis management. Legal basis of crisis management in Poland. Crisis management process. Basic types of threats – sources of crisis situations. A crisis situation. Crisis management system in Poland. Effectiveness in crisis management.
9.	Safety Common	The essence of public safety. General security and national security. Mechanisms shaping public safety. Rescue. Civil protection. Civil Defense. Fire protection. Critical infrastructure protection. Organization of the protection of human life and health, material and cultural goods and the natural environment Methods and tools used to ensure public security in Poland and the EU.
10.	Safety Internal	Perception of security. Political determinants of internal security. Institutional system of internal security. Administrative police in the internal security system. Private entities in the organization of internal security. Organization of security in the region. Organization of security in the district. Organization of security in the district.
11.	Data analysis Survey	Creating measurement tools. Sampling. Preliminary analysis. Schedule analysis. Contingency tables, boundary and conditional distributions. Analysis of single-choice and multiple-choice questions. Significance and strength of the relationship between nominal and ordinal variables. Hypothesis testing.
12.	Analysis Multidimensional	Methods of graphical presentation of multidimensional data. Multiple regression analysis. Analysis of canonical correlations. Principal components analysis. Exploratory Factor Analysis (EFA). Multidimensional scaling. Linear ordering. Cluster analysis.

No.	Item Name	Curriculum content
13.	Test procedures Evaluation	The concept of evaluation research. History and institutionalization of evaluation research. Types of evaluation research – the concepts of "impact assessment", "action research". Differentiation of evaluation research in terms of their social functions. Experimental designs in evaluation studies. The Concept of Experimental Society by A. Etioni. Monitoring and evaluation. Elements of cost-benefit analysis in evaluation research. Measurement problems in evaluation research.
14.	The theory is logical Argument	Logical argumentation. Deductive, reductive and inductive inferences. Diagrams and argumentation diagrams. Recognizing arguments. Diagram. Classified premises and conclusions. Elements of the evaluation of argumentation. Acceptability of premises. Reliability of sources. Relevance.
15.	Forecasting and simulations in security	Forecasting and social practice. Social premises for predicting behavior. Forecast vs. decision-making. Model methods. Extrapolation of trends. Validity, admissibility and error of the forecast. Forecasting based on time series. Forecasting based on econometric models. Heuristic forecasting models. Social simulations.
16.	Modern technology in security	Know-how, modern technologies and their importance in ensuring safety. Modern technologies in the defense and protection system. Modern technologies in the economic security system of the state. Modern technologies in the social security system. The use of modern safety technologies in electricity generation, in the transport system, in the protection of critical infrastructure, in the protection of the natural environment.
17.	Philosophy of Sciences Safety	Origins, subject and branches of philosophy and philosophy of security as the most general knowledge about security. The genesis and types of human knowledge in philosophical discourse (sources: mystical, intuitive, philosophical and scientific; types: scientific, theoretical, practical and intuitive). The logic of scientific discovery, revolution in science and the progress of knowledge in the view of contemporary epistemology. Semantic analytics of the name security and types of its understanding – the essence of security in philosophical terms. A natural and conventional concept of security. Materialistic, idealistic and realistic concepts in the hermeneutic anchoring of security. The Praxeological Concept of the Four Simple Acts and Universal Methods of Shaping Security. Tendencies in Broadening, Deepening and Thickening Security Studies The Method of War, Peace, Non-Peace and Non-War in Praxeological Approach. Philosophical problems of security in contemporary societies of control and surveillance from the perspective of dataism and technohumanism.
18.	Modern terrorism	Basic concepts and their meaning. The origins of terrorism. Causes of modern terrorism. The main factors generating and escalating terrorism. Systematization of the causes of terrorism. A triad of terrorist motivation. Key elements and types of terrorist threat. The scope and nature of terrorism at the beginning of the 21st century. Effects of terrorism. Preventing and combating terrorism.
19.	Morals and culture Security in relationships National and international	The essence and importance of the security culture (KB) and morale (M) of physical and legal entities in internal and international relations. Psychosocial and praxeological models and "mechanisms" of KB and M functioning – relations between them. Safety culture (KB) and morale as types of key resources and competitive advantage factors in "normal" and crisis situations. Security culture as an interface integrating the security areas in question and the national security system (SBN). Intuitive and scientific ways of diagnosing and improving KB and M. Security culture and morale in times of information warfare and asymmetric conflicts
20.	History Security	Military, political and economic security of medieval Polish and the Polish-Lithuanian Commonwealth until its collapse. The main problems of European security in the nineteenth century. Polish national uprisings of the nineteenth century. World War I. Determinants of international security in the interwar period. Military, political, economic and social security of the Republic of Poland (1918–1939). World War II. International security in the second half of the twentieth century. U.S.-USSR relations and their impact on international security. Military, political and economic security of Poland after World War II.
21.	Communication Strategy	Characteristics of strategic communication (terminology, essence, responsibility in NATO). Public diplomacy (terminology, essence, structures). Informing the public (terminology, essence, structures). Information operations (methods, views of NATO, views and structures of the USA, Polish views). Psychological operations (methods and techniques of action, US structures, German structures, Polish structures, British structures).

No.	Item Name	Curriculum content
22.	Political sector Security	Political security. Concepts. Political security in security sciences. Forms and types of political threats as well as determinants and research of political security. A model of institutionalization of political security. The need for citizen security and the tasks of a democratic state. The crisis of civic identity. Power as a factor of security. Security strategy as an instrument of political security. The influence of interest groups on political decisions. Media – shaping public opinion. The basic dilemma of political security.
23.	Shaping Security Military in the 21st century	Characteristics of military security of selected states and associations of states in relation to the methodology of identification and description of challenges, and thus potential opportunities and threats to the existence and development of individual societies. The terminology of military security, the components of this security, the impact of these elements on the state and process of military security in the face of identified and described challenges (opportunities and threats) in the perspective of the current century.
24.	Safety Information	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPauduli, Biby, Shiver-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
25.	The economic dimension of safety	Defining economic security and its dimensions. Economization of state security. Typology of threats to economic security. The state and the national economy in the face of contemporary cultural and civilizational changes. Economic aggression in international relations. Financial crises. Activities of transnational corporations. Technological espionage as a threat to economic security. State activity to ensure economic security.
26.	Safety Energy facing Transformation socio-economic	The impact of socio-economic transformation on the functioning of the energy sector of developing and developed countries, and thus also on the energy security of these countries. A parallel process of influencing the way the energy industry operates, as well as the functioning of the energy security sector to protect the industry against threats (both old and new, generated by current socio-economic changes).
27.	Social Conditions Security modern states	The essence of social security. Social security and the model of the state system. Mechanisms shaping social security. Concepts of social security. Models of social security in the EU. Problems of social security in Poland and ways to overcome them. EU activities for social security.
28.	Combating and corruption prevention	Seminar classes. Threats to state security caused by corruption behaviors. Forms of corruption and the offences associated with them. Legislative activities and services responsible for combating and reducing corruption and the principles of building effective anti-corruption solutions in public organizations and in the private sector.
29.	Operational methods of combating serious criminal crime	Seminar classes. Statutory operational methods, i.e. operational control, covertly supervised shipment, controlled purchase and controlled giving/acceptance of financial benefits, used to combat and prevent serious criminal crime. The rules for granting consent to the use of the indicated tools for combating this type of crime and the use of evidence obtained in this way in criminal proceedings. Methods of controlling the use of such non-procedural measures to ensure state security.
30.	Safety Organic on a global scale regional and national	Types of challenges (opportunities and threats) generated by climate change in the area of environmental security. Identification of the impact of climate change on the national security of selected societies on a national, regional and global scale.
31.	Cultural security factors	Culture: concept, categories, identity. Cultural security: conceptual aspects, cultural security in the area of spiritual culture, security in the area of material culture. Cultural threats to the security of the Republic of Poland. The cultural security system of the Republic of Poland. Cultural aspects of international relations. The Cultural Background of International Conflicts. Security Culture – National and International Aspects

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 10/WAT/2024 of 28 February 2024

on the establishment of the "Curriculum at the Doctoral School of the Military University of Technology - 2024 edition"

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2023, item 742, as amended), in connection with § 21(1)(21) of the Statute of the Military University of Technology constituting an appendix to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), the following is resolved:

§ 1

The "Curriculum at the Doctoral School of the Military University of Technology - 2024 edition" *is hereby established*, constituting an attachment to the resolution.

§ 2

The curriculum referred to in § 1 is in force from the academic year 2024/2025.

§ 3

Doctoral students of the Doctoral School of the Military University of Technology who started their education before the academic year 2024/2025 may update their Individual Education Programmes on the basis of this programme.

§ 4

The resolution shall enter into force on the date of its adoption.

In place of the President of the Senate

(-) Professor Jerzy MAŁACHOWSKI

Attachment to the Resolution of the Senate of WAT No.
10/WAT/2024 of 28 February 2024

CURRICULUM

DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

- edition 2024

I. General principles

1. The curriculum at the Doctoral School of the Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics, electrical engineering and space technologies** - a field of engineering and technical sciences;
    2) **information and communication technology** - a field of engineering and technical sciences;
    3) **civil engineering, geodesy and transport** - a field of engineering and technical sciences;
    4) **materials science** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security studies** - a field of social sciences;
    7) **chemical sciences** - a field of exact and natural sciences.
2. The learning outcomes take into account the requirements specified for the 8th level of the Polish Qualifications Framework.
3. Number of semesters: **8**
4. Number of ECTS credits – min. **30 points**
5. The number of compulsory courses is 100 hours and 20 hours of practical training carried out in the form of conducting classes or participating in them and corresponds to a total of 10 ECTS credits, and the number of optional courses is at least 200 hours and corresponds to at least 20 ECTS credits**.** Optional courses may include classes in optional modules of subjects carried out at MUT for at least 100 hours and 10 ECTS credits, courses taught at another university or scientific institution in Poland or abroad, and other forms of education, e.g. apprenticeships, internships at and outside the Military University of Technology, in particular at another university or institution in Poland or abroad.
6. Language of conducting:
    a. **Polish or English –** only in the case of subjects, internships or other forms of education indicated in the Individual Education Programme (IPK),
    b. **English –** in the case of education in a scientific discipline in English.
7. The program is valid from **the academic year 2024/2025.**
8. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:
   Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is the professional preparation of future staff in the fields of engineering and technology, exact and natural sciences and social sciences, in the field of military technology and security technology. The task of the Doctoral School is to ensure the transfer of the latest knowledge to doctoral students, the development of skills and improvement of competences at the highest level, as well as the cultivation of patriotic traditions and responsibility for the Homeland in broadly understood aspects, both military and civilian, in accordance with the principle "Omnia Pro Patria" – "Everything for the Homeland". The activities of the Doctoral School

correlate with the strategic objectives of the Academy's development in terms of strengthening the position of the Military University of Technology in the system of Polish and European higher education, including as the leading educational pillar of higher military education and the expert and research base of the Ministry of National Defense, as well as other ministries. In addition, it emphasizes the elite nature of the Academy as a university conducting innovative didactic and scientific activities, also developing international cooperation in this field.

9. Prerequisites for the candidate for the Doctoral School

   The candidate should have a Level 7 qualification. Polish Qualifications Framework (Master's degree, Master's degree or equivalent) and complete a Master's degree in a field related to the scientific discipline conducted at the Doctoral School or have scientific achievements in this discipline. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may admit a person who is a graduate of first-cycle studies or a student who has completed the third year of uniform master's degree studies. Detailed requirements are set out in the rules of recruitment to the Doctoral School established annually by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for subjects for which the university learning outcomes are required;
2) in the description *component code* column - reference of the assumed learning outcome to the appropriate code of the description component of the first- and second-cycle learning outcomes at level 8 of the Polish Qualifications Framework (PQF 8).

Effect number symbols	**Expected learning outcomes**	**code description component**
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_W P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*

Effect number symbols	Expected learning outcomes	code description component
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
Skills: the graduate is able to		
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8U_U P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8U_U P8S_UW*
D_U03	*independently plan and act for their own development and inspire and organize the development of others,*	*P8U_U P8S_UU*
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks , in particular:* *− define the purpose and object of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8U_U P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8U_U P8S_UK*
D_U10	*participate in scientific discourse, exchange of experiences and ideas, also in the international environment*	*P8U_U P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*
D_U13	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*
	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_K P8U_KK*
D_K02	*taking into account the challenges in the professional and public sphere, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_K P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8U_K P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8U_U P8S_KK*

Effect number symbols	Expected learning outcomes	code description component
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8U_U P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8U_U P8S_KO*
D_K07	*initiating activities in the public interest*	*P8U_U P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8U_U P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including:* *− conducting scientific activity in an independent manner,* *− respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8U_U P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes, to the extent resulting from the implementation of the education programme, including an individualised learning programme, is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- completion of courses included in the Basic Module, including a doctoral seminar in the subject Analysis of the research area,
- credit for courses from the Optional Module of a discipline or scientific disciplines, professional practice and subjects carried out outside the Military University of Technology and other forms of education[1] included in the Individual Education Program (IEP, IPK).

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.
2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.
3. The curriculum includes at least 300 hours of classes[2] and at least 20 hours of professional internships in the form of conducting classes or participating in them - at least 30 ECTS credits in total.
4. The doctoral student's education program consists of:
   1) the basic module for doctoral students of all scientific disciplines conducted at the Doctoral School, 100 hours with a total of 9 ECTS credits;
   2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned, subject to sections 6, 7 and 8;
   3) 20 to 180 hours of professional internships in the form of classes or participation in them from the third to the seventh semester of education, – max. 60 hours per year (in accordance with the individual curriculum), which are assigned 1 ECTS credit, regardless of the number of hours of practice.
   4) optionally, courses taught outside the Military University of Technology and other forms of education on an hourly basis and the number of ECTS credits specified in an individual curriculum.

[1] if they appear in IPK

[2] classes may include courses taught outside the Military University of Technology and other forms of education

5. A doctoral student is required to complete the basic module and 20 hours of professional practice in the form of conducting classes or participating in them. A doctoral student, in consultation with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. It is allowed for courses to come from different scientific disciplines and to be taught at another university or research institution.
6. In the case of planned completion of courses outside MUT and other forms of education (e.g. internship, internship at and outside MUT), the supervisor determines the number of ECTS credits and the learning outcomes to be achieved, provided that the number of hours of courses taught at MUT from the optional module cannot be less than 100 hours and 10 ECTS credits.
7. In the case of education for foreigners in English, the subjects included in the basic module referred to in Chapter V, concerning the issues of Polish regulations, may be replaced by other subjects. Decisions on the introduction of new subjects are made by the Director of the Doctoral School in consultation with the Chairman of the Scientific Discipline Council, within which the education of foreigners is conducted.
8. The implementation of the education programme, taking into account the provisions of sections 5-7, should ensure that the candidate achieves the assumed learning outcomes specified in Chapter II.
9. By the end of the first semester of education, the doctoral student submits an individual education program to the director of the Doctoral School, approved by the supervisor or supervisors.
10. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year, subject to paragraph 11
11. Classes for foreigners providing education in English may be planned centrally or as part of a scientific discipline, taking into account the subjects referred to in paragraph 7.
12. Classes in the subjects of the optional modules are planned according to individual curricula.
13. Classes in the subjects of the basic module or optional modules can be carried out in a stationary or remote or hybrid form.
14. The decision on the form of conducting classes in the subjects of the basic module is made by the director of the Doctoral School, and in the case of subjects of optional modules, by the lecturer.

V. Modules of the curriculum

No.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, obligatory for doctoral students of all disciplines[3] (I-II sem.)				
1.	Higher education	20	1	*D_WWAT01, D_W05, D_W06, D_UWAT01, D_U03, D_K01, D_K02*
2.	Rules for conducting classes	10	1	*D_WWAT01, D_UWAT01, D_U03, D_U13, D_K01, D_K06*
3.	The process of applying for research funding	10	1	*D_W05, D_U7, D_U12, D_K01, D_K03,D_K04*
4.	Plan your experiment	16	1	*D_W04, D_U04, , D_K04*
5.	Methodology of conducting scientific research	10	1	*D_WAT02, D_U01-U05*
6.	Ownership and commercialisation of research	10	1	*D_W05, D_W06,D_U06*
7.	Scientometrics and bibliometrics in scientific activity	4	1	*D_W05, D_U08, D_K03, D_K04*
8.	Analysis of the research area[4]	20	2	*D_W01, D_W02, D_W03, D_W4, D_U08*
Optional modules related to the scientific discipline (III-VII sem.)				
1	**Automation, electronics, electrical engineering and space technology**	min. 200 hrs[5]	min. 20 points	*List of items attachment V.1 - page 11*
2	**Information and communication technology**			*List of items attachment V.2 - p. 13*
3	**Civil engineering, geodesy and transport**			*List of items attachment V.3 - page 16*
4	**Materials science** (engineering)			*List of items attachment V.4 - p. 17*
5	**Mechanical engineering**			*List of items attachment V.5 - page 19*
6	**Chemical sciences**			*List of items attachment V.6 - p. 22*
7	**Security studies**			*List of items attachment V.7 - p. 23*
Internship (III-VII sem.) - in accordance with the individual education program				
1	Professional practice in the form of conducting classes or participating in them	20-180 hours	1	*D_WWAT01, D_UWAT01 D_K01*
Subjects taught outside the Military University of Technology and Other forms of education (III-VII sem.) **-** Optionally according to the individual training program				
1	Subjects outside MUT and, for example, internships, internships carried out at and outside MUT at another university or scientific institution in Poland or abroad	*The number of hours, ECTS credits and reference to learning outcomes is determined by the supervisor in an individualised learning programme*		

[3] in the case of education for foreigners in English, the subjects included in the basic module, concerning the issues of Polish regulations, may be replaced by other subjects determined by the Director of the Doctoral School.

[4] course carried out on an individual basis with a supervisor or supervisors or a supervisor and an assistant supervisor completed with a doctoral seminar

[5] the minimum number of hours of classes in the Optional Module may be reduced by the implementation of other forms of education, the sum of ECTS credits for the Optional Module and other forms of education may not be less than 20 points, while maintaining at least 100 hours of classes at MUT in the Optional Module

VI. Framework Programme

The framework program includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

No.	Name Item /discipline Scientific	Curriculum content
Basic module, compulsory for all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Policy conducting classes	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	Process Inference for financing Research	The process of applying for funding for basic scientific research. Statutory activities, financing of domestic and foreign scientific internships for young scientists starting their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Science and Higher Education, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Plan your experiment	Determined and randomized experiment plans. Measures of position and dispersion of measurement results. Assessment of the significance of the impact of input quantities on the output quantity. Specify a function that approximates the function of an object. Assessment of the adequacy of the function of the facility and the significance of its coefficients. Experiential optimization.
5.	Methodology Conduct research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that needs to be solved – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6.	Proprietary Rights and commercialization Research	Basic information on the methods of intellectual property protection, in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection. Issues of commercialization of the results of scientific research and development works.
7.	Scientometrics I Bibliometrics in the activity Scientific	Scientometric and bibliometric indicators used in international bibliographic databases (Scopus, WoS), as well as national requirements related to the evaluation of researchers. Dissemination of scientific activities and research results, with particular emphasis on open access policy. The use of bibliographic databases and e-sources in scientific research. Tools supporting the collection of materials supporting the writing of scientific papers.
8.	Area Analysis Research	Seminar classes supervisor – PhD student. Analysis of the state of knowledge in the field of research issues selected by the doctoral student. Literature review. Defining the research problem (goal, research questions, hypotheses) and preliminary determination of the methodology. Preparation of a presentation for the first doctoral seminar. Preparation of a draft of an individual education program.

Lp.	Course name / discipline Scientific	Curriculum content
Optional modules related to the scientific discipline		
1	Automation, electronics, electrical engineering and space technology	*Annex VI.1 – page 25*
2	Information and telecommunication technology	*Annex VI.2 – page 32*
3	Civil engineering, geodesy & Transpor	*Annex VI.3 – page 41*
4	Materials science	*Annex VI.4 – page 45*
5	Mechanical engineering	*Annex VI.5 – page 51*
6	Chemical sciences	*Annex VI.6 – page 60*
7	Security studies	*Annex VI.7 – page 64*

VII. Organisation of apprenticeships and other forms of education

Internships are carried out in the form of teaching classes or participation in conducting them for a minimum of 20 hours in semesters III - VII. They can be carried out at the Military University of Technology or other domestic or foreign institutions

In special and justified cases (e.g. disability of a doctoral student), the supervisor may exempt the doctoral student from the obligation to undergo professional practice by indicating an additional optional subject or another form of education in the amount of at least 2 ECTS credits.

Other forms of education i.e. internships (other than teaching classes or participating in their conduct), internships within and outside the MUT, at a university, domestic or foreign institution, institutions and enterprises whose scope of activity is related to the subject of the doctoral dissertation may be carried out from the third to the seventh semester. Other forms of education, their number of hours and the allocation of ECTS credits are decided by the supervisor in the Individul Education Program (IEP). With the consent of the supervisor, apprenticeships or other forms of education may also be carried out in the second semester of education.

Apprenticeships and other forms of education are subject to descriptive assessment (pass/no pass.) in the academic year in which they were held in accordance with the rules set out in the Rules of the Doctoral School of the Military University of Technology.

VIII. Educational plan

The education plan (see below) consists of a general part – basic module, compulsory for all doctoral students (for all disciplines) of the first year (semester I and II) of education and an Individual Education Program (IEP) for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

The Individual Education Program (IEP) for Doctoral Student semesters III to VII is created on the basis of the optional modules credited to the specific discipline, however the subject/s from other disciplines can be selected, and other form of education.

PLAN OF EDUCATION AT THE DOCTORAL SCHOOL FROM THE ACADEMIC YEAR 2024/2025
ALL SCIENTIFIC DISCIPLINES CONDUCTED AT THE DOCTORAL SCHOOL

	Modules/Subjects	total hours/ ECTS point		number of hours/ECTS points per semester:													
				I		II		III		IV		V		VI		VII		VIII	
		Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS
Basic module, compulsory for all disciplines																			
	Total	**100**	**9**	**50**	**4**	**50**	**5**												
1	**Didactic of Higher education**	**20**	**1**	**20**	**1**														
2	**Rules for conducting classes**	**10**	**1**	**10**	**1**														
3	**The process of applying for research funding**	**10**	**1**			**10**	**1**												
4	**Design of experiment**	**16**	**1**			**16**	**1**												
5	**Research methodology**	**10**	**1**			**10**	**1**												
6	**Property rights commercialization of scientific research**	**10**	**1**			**10**	**1**												
7	**Scientometrics and bibliometrics in scientific activity**	**4**	**1**			**4**	**1**												
8	**Analysis of the research area**	**20**	**2**	**20**	**2**														
Optional modules related to the scientific discipline - 301 subjects																			
1	**Automation, electronics, electrical engineering and space technologies - 54 subjects**	**min. 200 hours***	**min. 20 ECTS***					**According to the Individual Education Program (IEP)**											
2	**Information and communication technology - 48 subjects**																		
3	**Civil engineering, geodesy and transport - 27 subjects**																		
4	**Materials engineering - 42 subjects**																		
5	**Mechanical engineering - 78 subjects**																		
6	**Security studies- 31 subjects**																		
7	**Chemical sciences - 21 subjects**																		
Apprenticeships																			
1	*Internships in the form of conducting classes or participation in conducting them*	**20-180**	**1**					**According to the Individual Education Program (IEP)**											
Subjects carried out at another university or scientific institution, domestic or foreign - optionally in accordance with the IEP																			
1	*Subjects carried out in direct and remote form*	***according to IEP***						**According to the Individual Education Program (IEP)**											
Other forms of education - optional according to IPK																			
1	*e.g. internships, internships carried out in and outside the Military University of Technology, at another university or domestic or*	***according to IEP***						**According to the Individual Education Program (IEP)**											

** The total number of ECTS credits under the IEP must be min. 21 points, min. the number of hours in the Optional Module may be reduced to 100 hours and 10 points by completing courses outside the Military University of Technology and other forms of education to which the number of hours and ECTS credits has been assigned*

IX. Internal system for ensuring the quality of education at the Doctoral School

The internal education quality assurance system at the Doctoral School is an element of the Education Quality Assurance System at the Military University of Technology.

As part of the preparation of doctoral students for high-level research work, the importance of continuous monitoring and systematic improvement of the quality of their education increases. The education quality policy, resulting from the mission and development strategy of the MUT is implemented at the Academy by setting appropriate goals and quality standards, as well as by implementing, continuously monitoring
and improving the internal quality assurance system.

The scope of the internal education quality assurance system at the Doctoral School includes in particular:

1) monitoring and analysis of the formal and legal side of the teaching process;
2) periodic review and updating of education programs;
4) analysis of the conditions for the implementation of the teaching process;
5) monitoring factors affecting the quality of education.
6) analysis of the functioning and development of methods for improving the quality of education.

Optional subjects
Scientific discipline: automation, electronics, electrical engineering and space technologies

No.	Item/subject Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Computer Network Administration**	**20**	**3**	*D_W03*	*winter*
2.	**Acoustic Electronics**	**30**	**3**	*D_W04, D_W05*	*winter*
3.	**Computer-aided analysis of experimental data**	**30**	**3**	*D_W03, D_U06*	*winter*
4.	**Smart Antennas**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
5.	**Digital Image Processing**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
6.	**Optical Radiation Detectors**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
7.	**Electromechanical energy and signal converters**	**30**	**3**	*D_W01, D_U05*	*winter*
8.	**Laser Physics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
9.	**Physics of laser media**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
10.	**Photovoltaics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
11.	**Supercontinuum Radiation Generation**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
12.	**Imaging Information Engineering**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
13.	**Encoding and recognition of radio transmissions**	**30**	**3**	*D_U05*	*winter*
14.	**Crystallography**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
15.	**Laser absorption spectroscopy in gas sensors**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
16.	**Laser-plasma X-ray and extreme ultraviolet (EUV) sources**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
17.	**Lasers for medical applications**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
18.	**Pico- and femtosecond lasers**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
19.	**Fiber lasers**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
20.	**Mathematical models of the electromagnetic field**	**30**	**2**	*D_W02, D_W03*	*winter*
21.	**Finite Element Method**	**30**	**3**	*D_W02, D_W03*	*lukewarm*
22.	**Methods of analysis and measurement of random signals**	**30**	**3**	*D_W02, D_U05*	*lukewarm*
23.	**Data mining methods and tools**	**30**	**3**	*D_W02, D_W04*	*winter*
24.	**Methods of logical synthesis**	**30**	**3**	*D_W02, D_W03*	*winter*
25.	**Minimizing the electromagnetic susceptibility of infiltration of IT devices**	**30**	**3**	*D_U05*	*winter*
26.	**Nonlinear Laser Conversion**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
27.	**Scientific and engineering calculations**	**30**	**3**	*D_W04*	*winter*
28.	**Optoelectronics in safety systems**	**30**	**2**	*D_W01, D_W02, D_W03*	*lukewarm*

No.	Item/subject Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
				D_U010, D_K03, D_K05	
29.	**Coherent Light Optics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
30.	**Plasma in science and technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
31.	**Remote Sensing Basics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
32.	**Basics of knowledge about viruses and other pathogens for engineers**	**30**	**3**	*D_W01, D_W02, D_U01, D_U07, D_K01*	*winter*
33.	**Measurements of basic parameters of laser radiation**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
34.	**Designing safety systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
35.	**Programmable and Purpose-Built Circuits**	**30**	**3**	*D_W01, D_U05*	*lukewarm*
36.	**Acoustic sensors**	**20**	**2**	*D_W04, D_W05*	*winter*
37.	**Microwave sensors in radiolocation**	**20**	**2**	*D_W02, D_U04*	*lukewarm*
38.	**Smart radio networks**	**30**	**3**	*D_W01, D_W03*	*winter*
39.	**Optical Spectroscopy for Life Sciences**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	
40.	**Digital systems in optoelectronic devices**	**30**	**2**	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*	*winter*
41.	**Test and measurement systems in the test laboratory**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
42.	**Fiber optic technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
43.	**Terahertz technique**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
44.	**Information concealment technique (steganography)**	**30**	**3**	*D_W01, D_W02, D_U05*	*lukewarm*
45.	**Techniques in Biomedical Engineering**	**30**	**3**	*D_W01, D_W02, D_U01, D_U07, D_K01*	*winter*
46.	**Field theory**	**30**	**3**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
47.	**Thermal imaging and infrared technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
48.	**Optical Radiation Detection Systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
49.	**Laser beams**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
50.	**Modern transducers measuring physical quantities**	**30**	**3**	*D_W01, D_U05*	*winter*
51.	**Selected issues of the operation of anthropotechnical systems**	**30**	**3**	*D_W08, D_U05 i 06*	*lukewarm*
52.	**Advanced microelectronics technologies**	**30**	**3**	*D_W01, D_U05*	*lukewarm*
53.	**Applications of lasers in technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*lukewarm*
54.	**Advanced techniques for digital system design in FPGAs**	**30**	**3**	*D_W02, D_W03, D_U07, D_U09, D_K05*	*lukewarm*

Annex V.2
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: technical informatics and telecommunications

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
1.	**Quantum Algorithms III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
2.	**Algorithm Analysis III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
3.	**Analysis and synthesis of visual information III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
4.	**Next-generation wireless systems (NG)**	**20**	**2**	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*lukewarm*
5.	**ICT Systems Diagnostics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
6.	**Efficiency of ICT systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
7.	**Elements of forecast theory III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
8.	**Software Evaluation III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
9.	**Physical Foundations of Quantum Information III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
10.	**Computer Graphics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
11.	**Software Quality Engineering III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
12.	**Cryptology III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
13.	**Mathematical Methods of Decision Support III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
14.	**Discrete Mathematics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
15.	**Generative and aspective methods in manufacturing software III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
16.	**Numerical methods III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
17.	**Multi-Criteria Optimization Methods III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
18.	**Mathematical Modelling III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
19.	**Modeling and verification of ICT networks III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
20.	**Modeling Conflict Situations III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
21.	**Business Process Modeling, Simulation and Analysis III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
22.	**Reliability of Systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
23.	**Optimization III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
24.	**Probabilistic III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
25.	**Stochastic Processes III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
26.	**Image Recognition and Processing III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
27.	**Neural networks and fuzzy logic III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
28.	**Smart radio networks**	**20**	**2**	*D_W01, D_W03,D_U010, D_K03, D_K05*	*winter*
29.	**Stochastic Exploitation Models III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
30.	**Computer Simulation III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
31.	**Database Systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
32.	**ICT systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
33.	**Decision support systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
34.	**Artificial Intelligence III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
35.	**Theoretical foundations of computer science III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
36.	**Graph and Network Theory III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
37.	**Project and Process Management III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
38.	**Complex Data Structures III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*lukewarm*
39.	**5G network application for military**	**30**	**3**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05*	*lukewarm*
40.	**Advanced cryptanalysis tools**	20	2	*D_W01, D_W02,D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
41.	**Probabilistic graph models: representation**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
42.	**Probabilistic graph models: the basics of inference**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
43.	**Probabilistic Graph Models: Inference Methods**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
44.	**Probabilistic graph models: parameter estimation**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
45.	**Probabilistic graph models and hybrid models**	20	2	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
46.	**GNSS – Systems and signals" (GNSS)**	20	2	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*winter*
47.	**Multidimensional Data Processing (WDP)**	20	2	*D_W01; D_W02; D_W03; D_U10; DU_04; D_K03; D_K05*	*winter*
48.	**Automated Battlefield Database Systems (SBD-ZPW)**	20	2	*D_W01; D_W02; D_W03; D_U10; DU_04, D_K03; D_K05*	*winter*

Optional subjects
Scientific discipline: civil engineering, geodesy and transport

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
1.	Safety and reliability of building structures	20	3	*D_W03; D_W05; D_U02; D_K02*	*winter*
2.	Dynamic interaction of building structures with a soil medium	20	2	*D_W02; D_U01; D_K05*	*lukewarm*
3.	Environmental physics	20	2	*D_W03; D_U04; D_K02*	*lukewarm*
4.	Modelling of thermal and humidity processes	20	2	*D_W03; D_U04; D_K03*	*lukewarm*
5.	Identification of loads and structural systems	20	2	*D_W02; D_U02; D_K02*	*winter*
6.	Investment process in the construction industry	20	2	*D_W01; D_U04; D_K05*	*lukewarm*
7.	Mechanics of road and airport runway soil foundations	20	3	*D_W03; D_U02; D_U04; D_K03*	*winter*
8.	Test methods for stiffness and load-bBearing Capacity of Road and Airport Pavements	20	2	*D_W03; D_U07; D_K07*	*lukewarm*
9.	Design methods for folding bridge structures	20	2	*D_W03; D_U01; D_U03; D_K01*	*winter*
10.	Design methods of the experiment	20	3	*D_W02; D_U01; D_K01*	*lukewarm*
11.	Modeling the Behavior of Reinforced Concrete Elements and Structures	20	2	*D_W02; D_U01; D_K01*	*winter*
12.	Geometric and Physical Nonlinearities in Structural Mechanics	20	2	*D_W03; D_U04; D_K05*	*lukewarm*
13.	Explosive effects on defensive structures	20	2	*D_W02; D_U01; D_K05*	*winter*
14.	Scheduling and costing systems for construction works	20	2	*D_W06; D_U06; D_K08*	*lukewarm*
15.	Engineering of building materials	20	3	*D_W04, D_U04, D_K05*	*winter*
16.	Cartographic methods of research	20	2	*D_W02, D_U05, D_U07, D_K03, D_K05*	*lukewarm*
17.	Spatial data exploration	20	2	*D_W02, D_W04, D_UWAT02, D_U01, D_U05, D_K03, D_K05*	*winter*
18.	Data science in geospatial research	20	2	*D_W02,D_W03,D_UWAT02, D_U01, D_U05, D_K03, D_K04*	*lukewarm*
19.	Advanced methods of implementation of studies photogrammetric	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
20.	Programming in spatial information systems	20	2	*D_W02, D_W05, D_U06, D_U10, D_K03, D_K06*	*winter*
21.	Reference systems in geosciences	20	3	*D_W02,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
22.	Global Geodetic Observing System	20	3	*D_W01,D_W03,D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*lukewarm*
23.	Modern photogrammetric techniques	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*lukewarm*
24.	Selected numerical methods in geodesy	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
25.	Methods of parallel data processing	20	2	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*lukewarm*
26.	Mathematical foundations of digital image processing	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
27.	Numerical methods with linear algebra	20	2	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*lukewarm*

Optional subjects
Scientific discipline: materials sciences (engineering)

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
1.	**Structural studies by X-ray diffraction**	**20**	**2**	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
2.	**Structural studies by scanning microscopy**	**20**	**2**	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*	*winter*
3.	**Mechanical properties testing of engineering plastics**	**20**	**2**	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
4.	**Physical basis of electro-optical effects in liquid crystals**	**20**	**2**	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*	*winter*
5.	**Calorimetric, thermogravimetric & volumetric methods for testing material properties**	**20**	**2**	*D_W01, D_W04, D_U05, D_K03*	*winter*
6.	**Semiconductor materials for optoelectronic applications**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*spring*
7.	**Nano and ultracrystalline engineering materials**	**20**	**2**	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
8.	**Nanoporous anodic aluminium oxide: synthesis, design & applications**	**20**	**2**	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U03, D_K01, D_K03, D_K05*	*spring*
9.	**Non-telecommunications applications of fiber optics**	**20**	**2**	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
10.	**Measurements of machine and equipment parts with using coordinate measuring techniques**	**20**	**2**	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*	*spring*
11.	**Experiment planning and data analysis with using Origin and Statistica**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
12.	**Basic properties of liquid crystals**	**20**	**2**	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*	*winter*
13.	**Keysight Vee and Lab View in control and data processing**	**20**	**2**	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*	*winter*
14.	**Designing technological processes for incremental direct deposition methods**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
15.	**Dielectric spectroscopy**	**20**	**2**	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*spring*
16.	**Structural determinants of material properties**	**20**	**2**	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*	*winter*
17.	**Modern methods of material characterization**	**20**	**2**	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*winter*
18.	**Contemporary information imaging systems and directions of their development**	**20**	**2**	*D_W01, D_W06, D_U01, D_U02, D_U05, D_K03, D_K04*	*winter*

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
19.	**High-energy ball milling and mechanical synthesis**	**20**	**2**	*D_W01, D_W01, D_U05, D_K03*	*winter*
20.	**Advanced materials for hydrogen storage**	**20**	**2**	*D_W01, D_W03, D_U01, D_K04*	*spring*
21.	**Basics of plasmonics and metamaterials**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
22.	**Optoelectronic imaging and information processing techniques**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
23.	**Selected materials and Functional Structures for Photonic Applications**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*spring*
24.	**Computer Image Analysis in Materials Science**	**20**	**2**	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*spring*
25.	**Additive manufacturing of functional materials**	**20**	**2**	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
26.	**Methods for amplifying light emission from broadband semiconductor nanostructures**	**20**	**2**	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U07, D_U10, D_K01, D_K03, D_K04, D_K09*	*winter*
27.	**Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals**	**20**	**2**	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U10, D_K03, D_K04, D_K05, D_K09*	*winter*
28.	**Modeling of semiconductor devices**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*winter*
29.	**High-entropy alloys – synthesis, structure, research and properties**	**20**	**2**	*D_W01, D_W01, D_U05, D_K03*	*winter*
30.	**Additive manufacturing of alloys based on intermetallic phases**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
31.	**Combinatorial fabrication and testing of engineering materials**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
32.	**Reactive mechanical grinding as a method of synthesis of modern materials for storing hydrogen in the solid phase**	**20**	**2**	*D_W01, D_W01, D_U05, D_K03*	*winter*
33.	**Additive techniques with elements of reverse engineering**	**20**	**2**	*D_W02, D_W04, D_UWAT02, D_U03, D_U07, D_K03, D_K05*	*winter*
34.	**Overview of additive techniques used in modern technology**	**20**	**2**	*D_W01, D_W03, D_UWAT02, D_D_U10, D_K03*	*winter*
35.	**Selected issues in 3D printing**	**20**	**2**	*D_W01, D_UWAT02, D_U01, D_U08,D_K04, D_K05*	*winter*
36.	**Researcher's workshop 1 – tools for writing scientific texts**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
37.	**Researcher's workshop 2 – writing scientific articles**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
38.	**Researcher's Workshop 3 – writing scientific articles**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
39.	**Quantum mechanics in examples**	**20**	**2**	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*winter*
40.	**Corrosion testing in materials science**	**20**	**2**	*D_W01, D_W02, D_W03, D_W04, D_U01, D_K05*	*winter*
41.	**Anodic oxides of copper and its alloys – production, characteristics and applications**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02. D_U01, D_U04, D_K03, D_K04, D_K06*	*winter*
42.	**Anodizing of aluminum alloys**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U01, D_U04, D_K03, D_K04, D_K06*	*winter*

Annex V.5
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: mechanical engineering

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
1.	Numerical Analyses in Load-Bearing Structures	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
2.	Autonomy of mobile robots	30	3	*D_U04, D_W03, D_K01*	*winter*
3.	Non-destructive testing of aircraft	30	3	*D_W02; D_W05; D_U01; D_K05*	*winter*
4.	Biomechanics of human body movement during a road accident	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*spring*
5.	Construction and operation of industrial robots	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
6.	Digital signal processing	30	3	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
7.	Dynamics of mechatronic system design	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*	*spring*
8.	Dynamics of car movement	30	3	*D_W03,D_W05, D_U02, D_U05, D_K04*	*spring*
9.	Dynamics and modeling of hydrostatic systems	30	3	*D_U04, D_W04, D_K01*	*winter*
10.	Dynamics of multi-member systems	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
11.	Impulse loads of motor vehicles – selected issues	20	2	*D_W04, D_U04, D_K09*	*winter*
12.	Computer-aided operation of machines	20	2	*D_W02, D_U05, D_K05*	*spring*
13.	Shaping a safe car body	20	2	*D_W01, D_U04, D_K01, D_K05*	*spring*
14.	Composite materials in mechanical engineering	30	3	*D_W01, D_W01, D_U04, D_K01, D_K05*	*spring*
15.	Finite Element Method	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
16.	Methods of analysis of numerical experimental research results	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
17.	Methods of testing the condition of machines	30	3	*D_W03, D_U05, D_K01, D_K03*	*winter*
18.	Experimental methods for investigating the thermophysical properties of solids	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*spring*
19.	Methods and techniques for testing the mechanical properties of materials	30	3	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*winter*
20.	Numerical Methods in Engineering Applications	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
21.	Numerical Methods in Mechanical Engineering	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
22.	Methods for designing and optimizing aircraft structures	30	3	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*	*spring*
23.	Constitutive Models of Materials in FEM Analysis	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
24.	Modelling of heat transfer processes	30	3	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*	*winter*
25.	Modeling and simulation of mechatronics issues	30	3	*D_W04, D_U04, D_K01*	*spring*

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
26.	Modeling and simulation of nonlinear mechanical problems	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
27.	Parametric modeling and structural optimization with FEM	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
28.	Flow modeling	30	3	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
29.	Modeling machine motion	20	2	*D_U04, D_W04, D_K01*	*spring*
30.	Modeling composite structures	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
31.	Modeling of the Contact Phenomenon in Structural Mechanics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
32.	Modeling and research of the processes of cooperation between the wheel and the road	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
33.	Modeling of car traffic and controls	30	3	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
34.	Modern technologies for bonding structural materials	30	3	*D_W01, D_W02, D_U05, D_K01, D_K05*	*spring*
35.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	20	2	*D_U04, D_W03, D_K01*	*winter*
36.	Renewable energy sources	30	3	*D_W06, D_U WAT02, D_K07*	*winter*
37.	CAE Engineering Software	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
38.	Experiment planning and optimization of mechanical objects	30	3	*D_W04, D_U04, D_K05*	*winter*
39.	Basics of road safety	20	2	*D_W03, D_W05, D_U02 D_U05, D_K04*	*winter*
40.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*spring*
41.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	30	3	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*winter*
42.	Fundamentals of Mechanics of Continuous Media	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
43.	LabVIEW environment in experimental research	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*spring*
44.	Starting processes of internal combustion engines	30	3	*D_W04, D_U04, D_K01*	*spring*
45.	Programming control systems for unmanned working machines and robots	30	3	*D_U04, D_W03, D_K01*	*winter*
46.	Mechatronic sensors	30	3	*D_W03, D_W04, D_U06, D_K01, D_K04*	*winter*
47.	Condition monitoring systems	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*spring*
48.	Aircraft Operation Systems	30	3	*D_W03; D_U01; D_K03*	*winter*
49.	Control systems in mechanical engineering	30	3	*D_U04, D_W03, D_K01*	*spring*
50.	Technologies for the production and processing of composite materials	30	3	*D_W01, D_W02, D_U04, D_K01, D_K05*	*spring*
51.	Selected solutions in the field of automotive technology and car motion	20	2	*D_W01, D_W03, D_U04 D_K01, D_K05*	*spring*
52.	Theory and organization of machine operation	30	3	*D_W04, D_U06, D_K03*	*winter*
53.	Thermomechanics of materials and studies of thermophysical properties	30	3	*D_W03, D_W04, D_U01, D_K03*	*winter*
54.	Tribology	30	3	*D_W03, D_U04, D_K05*	*winter*

No.	Item/subject name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
55.	Durability of aircraft structures	30	3	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*spring*
56.	Introduction to the equations of mathematical physics	30	3	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*	*spring*
57.	Modern machine and vehicle drive systems	30	3	*D_W03, D_U04, D_K05*	*winter*
58.	Modern test methods for internal combustion engines and vehicles	30	3	*D_W04; D_U01; D_U02; D_U03; D_U04; D_U05; D_UWAT01;*	*winter*
59.	Selected methods and techniques of temperature measurement	30	3	*D_W03, D_W04, D_U04, D_K05*	*spring*
60.	Selected problems of rocket technology	30	3	*D_W03, D_U04, D_K05*	*winter*
61.	Selected issues of waste gas treatment from motor vehicles	30	3	*D_W01; D_W02; D_W03; D_K03; D_K05; D_U010;*	*spring*
62.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	30	3	*D_W01; D_W02; D_W03; D_U05; D_K01; D_K03; D_K05;*	*winter*
63.	Selected issues of modern programming - introduction to modern programming languages.	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
64.	Fatigue strength and fracture mechanics of materials and structures	30	3	*D_W01, D_U04, D_K01*	*spring*
65.	Advanced methods of manufacturing products from sintered powders	30	3	*D_W04, D_U04, D_K01*	*spring*
66.	Advanced ballistics, modeling, and simulation	30	3	*D_W01, D_U04, D_K01*	*spring*
67.	Advanced Mathematics	40	4	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
68.	Advanced modeling in structural dynamics	30	3	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
69.	Advanced measurement systems	30	3	*D_W04, D_U04, D_K01*	*winter*
70.	Advanced Materials Testing Methods	30	3	*D_W01, D_W02, D_W04, D_U02, D_U04, D_U05, D_K01, D_K05*	*spring*
71.	Application of experimental mechanics in scientific research 1	30	3	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
72.	Application of experimental mechanics in scientific research 2	40	4	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*spring*
73.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	30	3	*D_W01, D_W02, D_W03 D_U05, D_K01, D_K03, D_K05*	*spring*
74.	Selected issues of vibration theory	20	2	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
75.	Selected issues in acoustoelectronics	30	3	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*spring*
76.	Numerical methods	30	3	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
77.	Electromagnetic field theory	30	3	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
78.	Quantum mechanics	30	3	*D_W01, D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*

Annex V.6
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: chemical sciences

No.	Item name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
1.	Analysis of Chemical Warfare Agents	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*	*winter*
2.	Chemistry and technology of liquid crystal materials	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*	*spring*
3.	Chemistry and technology of high-energy materials	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*	*spring*
4.	Polymer chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
5.	Chemical Foundations of Environmental Pollution	20	2	*D_W02, D_W03, D_UWAT02, D_K01, D_K03*	*spring*
6.	Physicochemical Properties of Carbon Materials	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*	*spring*
7.	Physicochemical aspects of the explosion	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*	*spring*
8.	History of chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
9.	Ionization methods in analytics	20	2	*D_W03, D_W04, D_UWAT02, D_K01*	*winter*
10.	Methods for preparing samples for analysis	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
11.	Spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
12.	Modeling and simulation computer programs in chemistry	40	4	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*	*winter*
13.	Modern nanoporous materials	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*	*winter*
14.	Modern methods of synthesis of functional organic compounds	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*spring*
15.	Biomedical polymers and biomaterials	20	2	*D_W02, D_W03, D_UWAT02, D_U09, D_K01*	*winter*
16.	Practical Tools and Concepts for Modern Organic Synthesis	20	2	*D_W01, D_W03, D_W04, D_UWAT02, D_U01, D_U04, D_K01, D_K05*	*winter*
17.	Synthesis of liquid crystals	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*winter*
18.	Modern analytical chemistry	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
19.	Advanced pyrotechnics	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
20.	Advanced spectroscopic methods	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
21.	Application of gas chromatography in physicochemical studies	20	2	*D_W WAT01, D_W01, D_W02, D_U WAT01, D_U WAT02, D_K01, D_K03*	*spring*

Optional subjects
Scientific discipline: security studies

No.	Item name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
1.	Social research in security sciences	40	4	*D_W WAT01; D_W01; D_W06; D_UO3; D_K03;*	*winter*
2.	Statistical methods in social research	40	4	*D_WO4; D_U O3; D_U04; D_KO1; D K03;*	*spring*
3.	Security risk management	30	3	*D_WO1; D_W03; D_UO3;*	*spring*
4.	Security Systems Project Management	30	3	*D_W03; D_U04; D_K05;*	*spring*
5.	Safety Systems Engineering	30	3	*D_W03; D_W02; D_UO6; D_U10; D_KO5;*	*winter*
6.	Safety propaedeutics	30	3	*D_W02; D W05; D_U01; D_K05;*	*winter*
7.	Strategies and concepts of state security management	30	3	*D_W02; D_U04; D_KO5;*	*winter*
8.	Crisis management in public administration	30	3	*D_WO1; D_W03; D_UO3; D_U12;*	*spring*
9.	Universal safety	30	3	*D_W02; D_W03; D_U01; D_K07;*	*spring*
10.	Internal security	30	3	*D_W02; D_W03; D_KO5; D_KO7;*	*spring*
11.	Survey data analysis	20	2	*D_WO4; D_U04; D_KO1;*	*winter*
12.	Multivariate analyses	20	2	*D_WO4; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
13.	Evaluation research procedures	20	2	*D_WO4; D_U04; D_U05; D_KO1; D K03*	*spring*
14.	Logic and theory of argumentation	20	2	*D_WO4; D_U01; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
15.	Forecasting and simulations in security	20	2	*D_W03; D_W04; D_U WAT01; D_U05; D U13; D_K03; D K04; D K05;*	*spring*
16.	Modern technologies in security	20	2	*D_WO1; D_WO2; D_U WATO1; D_UO6; D K03;*	*spring*
17.	Philosophy of security sciences	20	2	*D_W02; D_W03; D_U01; D_U05; D_KO1; D_K03;*	*winter*
18.	Modern terrorism	20	2	*D_W03; D_W06; D_U05; D_UO8; D_U09; D_KO1; D_KO6;*	*winter*
19.	Morale and Security Culture in National and International Relations	20	2	*D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*	*spring*
20.	Safety history	20	2	*D_W02; D_W03; D_U Wato2; D_U05; D_K03; D_KO9;*	*winter*
21.	Strategic communication	20	2	*D_WO1; D_WO3; D_UO6; D_U10; D_KO1; D_KO5*	*spring*
22.	Political security sector	20	2	*D_WO2; D_WO3; D_UO8D_U12; D_K02;*	*winter*
23.	Shaping military security in the 21st century	20	2	*D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*	*winter*

No.	Item name	number of hours	number of ECTS credits	reference to learning outcomes	implementation semester per year Academic
24.	Information security	20	2	*D_W06; D_U01; D_K05;*	*winter*
25.	The economic dimension of safety	20	2	*D_W03; D_U WAT02; D_U05; D_K03; D_K04; D_K05;*	*winter*
26.	Energy security in the face of socio-economic transformation	20	2	*D_W04; D_U WAT01; D_U WAT02; D U05; D_U13; D_K03; D_K04; D_K05;*	*spring*
27.	Social Determinants of the Security of Modern States	20	2	*D_W03; D_W06; D_U04; D_U05; D_KO5; D_K07;*	*winter*
28.	Combating and preventing corruption	20	2	*D_WO1; D_W06; DU01; D U02; DU01; D U12; D_K07; D_K02;*	*spring*
29.	Operational methods of combating serious criminal crime	20	2	*D_WO1; D_W03; DU01; D_U02; D_K07;*	*spring*
30.	Environmental security on a global, regional and national scale	20	2	*D _W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D 1.113; D_K03; D_K04; D_K05;*	*winter*
31.	Cultural security factors	20	2	*D_W03; D_W06; D_U04; D_U07; D_U10; D_K04; D_K05;*	*spring*

Annex VI.1
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics, electrical engineering & space technologies

Lp.	Item Name	Curriculum content
1.	**Computer Network Administration**	Human-machine relations. Socio-technical system. Communication of network devices. Fundamentals of Windows and Linux administration. Configuration of network devices and multimedia services in wired (Ethernet) and radio (5G) networks. Security, reliability and quality of ICT networks.
2.	**Acoustic Electronics**	Technical applications of elastic waves. Elastic waves in solids and their types. Elastic waves in confined media. Ferroelectric materials. Piezoelectricity. Electrostriction. Excitation and detection of acoustic volume waves. Acoustic volume wave filters and resonators. Construction and properties of interdigital transducers. Filters and dispersion lines with acoustic surface wave. Acoustic convolutors and Fourier processors. Acoustoelectronic sensors of mechanical quantities. Acoustoelectronic activators. Remote identification systems. Basics of synthesis of acoustic surface wave systems. Matching acoustoelectronic circuits to external circuits
3.	**Computer-aided analysis of experimental data**	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of uni- and multivariate data, processing of multivariate experimental results by means of linear transformations, problems of discrimination including methods of minimal-distance classification, nearest proximity, k-means and hierarchical grouping.
4.	**Smart Antennas**	Basic properties of smart antennas. Construction of antenna arrays. Applied solutions for shaping the characteristics of smart antennas. An overview of algorithms used in smart antennas. The principle of operation of adaptive patterns, the properties of their components and the configurations in which they are used in practice. Simulation models of the adaptation process.
5.	**Digital Image Processing**	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
6.	**Optical Radiation Detectors**	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, p-n, pin, APD photodiodes, with Schottky barrier, UV, VIS, IR detectors, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages. Detectors from type II superlattices. QWIP detectors. Barrier detectors.
7.	**Electromechanical energy and signal converters**	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements.
8.	**Laser Physics**	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
9.	**Physics of laser media**	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction. Energy levels

Lp.	Item Name	Curriculum content
		of transition group metal ions. Phenomena of energy transfer between ions in active media.
10.	**Photovoltaics**	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.
11.	**Supercontinuum Radiation Generation**	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
12.	**Imaging Information Engineering**	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality – key system components, application solutions.
13.	**Encoding and recognition of radio transmissions**	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
14.	**Crystallography**	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
15.	**Laser absorption spectroscopy in gas sensors**	Gas detection methods and defining gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
16.	**Laser-plasma radiation sources X-ray and extreme ultraviolet (EUV)**	Methods of producing X-rays and extreme ultraviolet radiation (EUV), basics of laser-generated plasma physics and X-ray and EUV optics, principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), examples of the use of these sources in science and modern technology.
17.	**Lasers for medical applications**	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications and the therapeutic and diagnostic effects obtained.

Lp.	Item Name	Curriculum content
18.	**Pico- and femtosecond lasers**	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
19.	**Fiber lasers**	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals - selected issues.
20.	**Mathematical models of the electromagnetic field**	Analytical and numerical methods of calculating the electromagnetic field. Differential relationships. Distribution. Orthogonal functions in wireless communication (LTE and 5G) and radiolocation. Wave propagation in materials and metamaterials. Simplified analytical models for calculating the radiation field. Techniques of calculation using potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the distant zone criterion. Computational numerical electromagnetism - differential methods.
21.	**Finite Element Method**	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
22.	**Methods of analysis and measurement of random signals**	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
23.	**Data mining methods and tools**	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
24.	**Methods of logical synthesis**	Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
25.	**Minimizing the electromagnetic susceptibility of infiltration of IT devices**	Electromagnetic disturbances as revealing emission. Measurement of the level of electromagnetic disturbance emissions. Uncertainty of measuring the level of electromagnetic disturbance emissions. Assessment of the quality of the results of measurements of the level of emission of disturbances. Protection of IT devices against electromagnetic penetration of information in the form of shielding and filtration. Factors affecting the required shielding efficiency and insertion loss of power supply filters. Methodologies for measuring parameters affecting the level of electromagnetic safety (shielding efficiency, insertion loss of power supply filters and signal filters, absorption and dispersion losses of materials). Examples of applications for the protection of IT devices against electromagnetic penetration of information.
26.	**Nonlinear Laser Conversion**	Elements of crystallography and crystal optics. Properties of uniaxial and biaxial crystals (KDP, LiNbO3, KTP, BBO, LBO, etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector

Lp.	Item Name	Curriculum content
		synchronizm. Generation II of the harmonic of light and the summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits
27.	**Scientific and engineering calculations**	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
28.	**Optoelectronics in safety systems**	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.
29.	**Coherent Light Optics**	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.
30.	**Plasma in science and technology**	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
31.	**Remote Sensing Basics**	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron paramagnetic resonance (EPR) (microwave spectroscopy). Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems. Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.
32.	**Basics of knowledge about viruses and other pathogens for engineers**	Presentation of selected issues of microbiology, epidemiology and public health in the light of the latest scientific discoveries. Using the achievements of bioinformatics to describe the world of microorganisms. Discussion of contemporary threats to human and animal health, basic groups of pathogens and ways to prevent infections and infestations. Zoonotic diseases. Gene and genome engineering, biotechnology, threats to ecosystems. The concept of One Health. Basics of immunoprophylaxis and hygiene. Pathogens are particularly dangerous in states of war and natural disasters.
33.	**Measurements of basic parameters of laser radiation**	Measurement methods of radiation spectrum, radiation power and energy, pulse duration and pulse repetition frequency, radiation beam divergence angle. Familiarizing yourself with the basics of laser safety
34.	**Designing safety systems**	Security strategy and principles for creating technical protections. Normative principles and a set of good industry practices. The range of technical protection measures that can be applied. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor and outdoor applications. Working conditions and restrictions on this account. Structure of the technical and detailed design. The scope of the technical executive design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Rules for detailed design and cost estimation. Design study in the field of technical and detailed design. Required resources to lay the groundwork for the project. Threat analysis. The concept of technical protection of the security system. Rules for conducting a hazard analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. Attack scenarios and verification of the possibility of technical

Lp.	Item Name	Curriculum content
		protection against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Methods of description and graphical representation of the technical design. The way documentation is organized. Examples of technical executive designs of critical infrastructure facilities. Documents related to the technical detailed design. Rules for the development of an investor's and "blind" cost estimate. The need to compile technical catalogues and technical data sheets of devices.
35.	**Programmable and Purpose-Built Circuits**	Technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). Principles of digital circuit topography design, power distribution and clock distribution, I/O buffers, IP blocks, and design tools.
36.	**Acoustic sensors**	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
37.	**Microwave sensors in radiolocation**	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
38.	**Smart radio networks**	Smart radio network concept. CR architectures. Semantic context of CR. Problems of teaching in the CR system. Dynamic spectrum management. Problems of reception in CR. Ad-hoc CR networks, collaborative MIMO. Standards for CR networks. Security problems in CR. Current research programs in the area of CR.
39.	**Optical Spectroscopy for Life Sciences**	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński's diagram Spectroscopic apparatus – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
40.	**Digital systems in optoelectronic devices**	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
41.	**Test and measurement systems in the test laboratory**	Signal conditioning systems. Control and measurement systems. Measurement signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
42.	**Fiber optic technology**	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.
43.	**Terahertz technique**	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
44.	**Information concealment technique (steganography)**	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of hiding data – cases and scenarios of action.
45.	**Techniques in Biomedical Engineering**	Fundamental issues and research techniques in biology and biomedicine will be discussed, including the main points of bioengineering and biotechnology. Thus, the skills necessary to undertake interdisciplinary research in these areas of

Lp.	Item Name	Curriculum content
		science will be developed. The principles of construction of essential research equipment will be presented, including measurements based on fluorescence excitation. The possibilities of bioinformatics analysis and international databases will be discussed. In addition, the principles of good laboratory practice and safe work in biomedical laboratories will be presented. Requirements for conducting reliable measurements and elaborating results in biomedical research and medical bioengineering will also be discussed.
46.	**Field theory**	Basic concepts and equations of the theory of the electromagnetic field. Maxwell's equations, Properties of mediums and boundary conditions. Fields at the boundary of medium separation, Electromagnetic field energy. Types of electromagnetic phenomena, Electrostatics and magnetostatics. Stationary and quasistationary electromagnetic fields, Maxwell's equations in complex form for harmonic waveforms, Electromagnetic waves. Wave equation for the area without sources, Uniform plane wave. Propagation parameters of a homogeneous plane wave, Propagation of a homogeneous planar wave in a lossless dielectric, Propagation of a homogeneous planar wave in lossy dielectrics, Propagation of a homogeneous planar wave in a good conductor, Structure of a homogeneous planar wave, Reflection and refraction of a homogeneous planar wave at a planar boundary of two different mediums. Reflection and refraction of a homogeneous plane wave at the boundary of two different dielectrics, Reflection of a homogeneous plane wave propagating in a dielectric from the plane surface of a conductive medium Electromagnetic potentials and radiation, Potentials of alternating fields, delayed potentials. Hertz vector potential, Field of elementary oscillator, Electromagnetic field at short distances from the oscillator, Electromagnetic field at long distances from the elementary oscillator, Wave phase, wave type, phase velocity, Propagation of waves in parallel systems of conductors and in waveguides, Transverse electromagnetic wave TEM, Transverse magnetic wave TM in a rectangular waveguide, Transverse electric wave TE in a rectangular waveguide, Base Type, Cuboid Cavity Resonator
47.	**Thermal imaging and infrared technology**	Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Radiometric calibration of a thermal imaging camera and its impact on the accuracy of remote measurement of temperature and radiation power. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Multi and hyperspectral infrared systems. Active thermal imaging, measurement capabilities and prospects for its application. Infrared imaging polarimetry.
48.	**Optical Radiation Detection Systems**	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
49.	**Laser beams**	Modeling of laser beams, Measurements of laser beam parameters. Design of optical paths of laser beams. Selected systems and systems of laser beam generation, shaping of laser beam transverse profiles, Folding of laser beams, propagation of laser beams in the atmosphere. Selected applications of laser beams in military science, technology and technology.
50.	**Modern transducers measuring physical quantities**	The concept of a measuring transducer and their classifications. Static and dynamic properties of transducers. Resistance strain gauges. Capacitive, piezoelectric, inductive, magnetoelastic, thermoelectric and pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic and acoustic transducers. Photoacoustic and photonic transducers. Integrated transducers.
51.	**Selected issues of the operation of anthropotechnical systems**	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
52.	**Advanced microelectronics technologies**	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy structure of semiconductors.

Lp.	Item Name	Curriculum content
53.	**Applications of lasers in technology**	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.
54.	**Advanced techniques for digital system design in FPGAs**	The Advanced FPGA Digital Systems Design Techniques course discusses issues related to, m.in others, the development of integrated digital systems in FPGAs, topographic design, effective use of design constraint attributes, preparation of functional tests, and good design practices. The course is divided into a theoretical part (lectures) and a practical part (laboratories and a project), and the results of the project work carried out are discussed at the seminar. Before taking the course, it is advisable to know the Hardware Description Languages (HDL) and the architecture of FPGAs.

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: technical informatics and telecommunications

Lp.	Item Name	Curriculum content
1.	**Quantum Algorithms III**	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	**Algorithm Analysis III**	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	**Analysis and synthesis of visual information III**	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	**Next-generation wireless systems (NG)**	Development trends. Networking. Radio interface techniques. Development of services and applications. Organization and management in NG systems. Applications of artificial intelligence (AI) and machine learning (ML). Bulk systems, D2D (Device-to-Device) systems, transport systems. Cognitive NG networks. Green communication.
5.	**ICT Systems Diagnostics III**	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
6.	**Efficiency of ICT systems III**	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
7.	**Elements of forecast theory III**	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.

Lp.	Item Name	Curriculum content
8.	**Software Evaluation III**	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation. Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
9.	**Physical Foundations of Quantum Information III**	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
10.	**Computer Graphics III**	Introduction to computer graphics, basic applications - computer animation, visual simulation, AR and VR systems. Vector graphics, raster graphics - representation of image data. Basic graphics standards - GKS, PHIGS, OpenGL. Raster algorithms - Bresenham, anti-aliasing, HLHSR. Geometric modeling - curves and surfaces, 3D objects. Geometric transformations - translations, rotations, scaling, projection. Color modeling - color perception, CIE, RGB, HLS, HSV(B) color models, color space transformations. Lighting modeling - lighting models, shading algorithms, raytracing, radiosity. Texture Modeling - Defining, mapping, and filtering textures.
11.	**Software Quality Engineering III**	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
12.	**Cryptology III**	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
13.	**Mathematical Methods of Decision Support III**	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-

Lp.	Item Name	Curriculum content
		making under uncertainty. Methods of determining the representation of sets of irreparable decisions. Methods for determining "approximate sets of optimal solutions". Examples of modeling decision support processes.
14.	**Discrete Mathematics III**	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers. Break down the number into its components. Asymptotics. Creating functions. Asymptotic notations. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
15.	**Generative and aspective methods in manufacturing software III**	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
16.	**Numerical methods III**	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
17.	**Multi-Criteria Optimization Methods III**	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
18.	**Mathematical Modelling III**	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin, maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of indistinguishability. Lower and upper approximation of the set. Approximation

Lp.	Item Name	Curriculum content
		accuracy. Optimal decisions with approximate data knowledge. Decision boards. Deterministic and non-deterministic rules. Uncertain variables.
19.	**Modeling and verification of ICT networks III**	Basics of verification of ICT systems (ST) based on formal models: model verification, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-2, CPN Tools, UPPAAL.
20.	**Modeling Conflict Situations III**	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
21.	**Business Process Modeling, Simulation and Analysis III**	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
22.	**Reliability of Systems III**	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for renewable facilities with zero renewal. Reliability of renewable facilities with non-zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of reliability structures. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
23.	**Optimization III**	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
24.	**Probabilistic III**	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.

Lp.	Item Name	Curriculum content
25.	**Stochastic Processes III**	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
26.	**Image Recognition and Processing III**	Introduction to the issues of digital recognition and image processing. Basic problems related to digital image acquisition and how to solve them. Frequency methods in digital image processing. Basics of using transforms in digital image processing and analysis. Spatial methods in digital image processing. Improving the quality of images with the use of convolutional, ranking, logical filters - their advantages, disadvantages, ways of implementation. Introduction to digital image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Basic methods of image identification: classification in the space of features, structural method.
27.	**Neural networks and fuzzy logic III**	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
28.	**Smart radio networks**	Smart radio network concept. CRAHN ad-hoc networks. CR hardware and software architectures. Semantic context of CR. Problems of teaching in the CR system. Policies in the CR network. Dynamic spectrum management. Sensing and spectrum sharing. Collaboration and competition in CR networks. Security problems in CR. Standards for CR networks and CR solutions in NG (New Generations) networks
29.	**Stochastic Exploitation Models III**	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
30.	**Computer Simulation III**	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simulation systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
31.	**Database Systems III**	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial

Lp.	Item Name	Curriculum content
		database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
32.	**ICT systems III**	Route and link availability control in the LAN environment: LAN link availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol: the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IPSec protocol, MPLS-based VPNs.
33.	**Decision support systems III**	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
34.	**Artificial Intelligence III**	Paradigms of artificial intelligence and areas of its applications, limitations of artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search, simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
35.	**Theoretical foundations of computer science III**	Algorithmic theory of information. Accuracy and correctness of algorithms. Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transformations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
36.	**Graph and Network Theory III**	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. A complex graph as a special type of graph. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms.

Lp.	Item Name	Curriculum content
		Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
37.	**Project and Process Management III**	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of projects and processes, planning the usability and functionality of project processes, planning the reliability of project activities, planning of control and verification of results, project risk management. Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the enterprise, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, management of communication in the project, methods and techniques of process improvement, models of process management development. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of

Lp.	Item Name	Curriculum content
		the rhomboid model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
38.	**Complex Data Structures III**	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.
39.	**5G network application for military**	5G network technologies. 5G use cases and system concept. 5G Network Architecture. 5G architecture elements and functionalities/roles. Millimeter wave communications. Device-to-device (D2D) communications. The 5G radio-access technologies. Machine-type communications. Massive multiple-input multiple-output (MIMO) systems. 5G Network Miltary Gaps. Sensors and effectors. Military scenarios (use cases). 5G network Military Application and use cases: 5G network in Spectrum Situation Awareness application (workshop). 5G network Military Application and use cases: (own work/seminar/workshop with teacher support).
40.	**Advanced cryptanalysis tools**	Elliptic curves, hyperelliptic curves and the concept of a diviser. Attacks on elliptic curves using transfer methods. Improper and degenerate curve attacks: An example of a practical attack on TLS-ECDH. Index method on elliptic curves over extended and straight bodies. Quantum attacks: Shor's and Grover's algorithm. Algebraic attacks. Transformation of factorization, discrete logarithm, and algebraic attacks into the QUBO problem. Application of quantum annealing in cryptanalysis. Isogeny-based cryptography. Practical attacks on the post-quantum scheme of SIDH. Cryptanalysis of selected cryptological problems.
41.	**Probabilistic graph models: representation**	Basics – probabilistics, graphs, information theory, optimization; Bayesian lattices and directed graphs; Markow's networks and undirected graphs; local probabilistic models.
42.	**Probabilistic graph models: the basics of inference**	Strict inference, elimination of variables; approximate inference: approximation with probability propagation, progressive sampling, Markov chains and Monte Carlo methods; inference algorithms, inference in state space models.
43.	**Probabilistic Graph Models: Inference Methods**	Information entropy; Transmitting confidence-rated messages; inference: variational, using Monte Carlo methods, using Markov chains.
44.	**Probabilistic graph models: parameter estimation**	Machine learning of graphical models; linear models; estimation of model parameters; models with incomplete data; Teach undirected models predictive models; Deep neural networks, Bayesian neural networks.
45.	**Probabilistic graph models and hybrid models**	Causality, complex decision-making model; models with hidden variables; statespace models; deep machine learning with graph models; decisions under uncertainty – selected algorithms for approximate inference and learning.
46.	**GNSS – Systems and signals" (GNSS)**	The state of the art of GNSS - the introduction to GNSS, the classification of systems, and areas of implementation of GNSS. The architecture of systems and elements – structures, description & characterization of physical processes, technical parameters, and areas of application. Signals in GNSS – classification, mathematical models of signals, propagation of signals, interferences of signals, methods of protection of signals. Modeling and simulation of systems and signals. Modeling and simulation of jamming and spoofing.
47.	**Multidimensional Data Processing (WDP)**	Basics of the theory of pattern recognition in data. Pattern definition, pattern classes, and the process of recognizing patterns in data. Pattern recognition techniques used. Division of data classification and grouping methods. Grouping criteria and methods. Threshold criteria (nearest and most distant neighbor). The

Lp.	Item Name	Curriculum content
		distance of Euclid, Sebestyen, Mahalanobis, Hamming, Cannber and selected similarity functions. Grouping methods based on hierarchical grouping algorithms. Construction of dendrograms. Extraction of distinctive features using polynomial interpolation (Lagrange analysis).
48.	**Automated Battlefield Database Systems (SBD-ZPW)**	Basic terminology and characteristics of databases. Requirements for databases. Database technology, data models, data structures, data model operators, integrity constraints. Developer tools. Database management system (software, functionality). Database System Architecture (ANSI/SPARC). Database system users. Implementation technologies. Communication architecture. Division of database systems. Entity relationship model, relationship modeling, entity hierarchy. Transformation, entity transformation rules, relationship transformation rules. Standardization and its process and basic concepts. The first (1NF), second (2NF), third (3NF) and fourth (4NF) normal form. Concurrent data access, data loss after failure. ACID transaction properties, transaction state diagram, logical vs. physical transaction, transaction model and classification, transaction executions. Operational data structures in the MIP model JC3IEDM database. Replication, transformation and data exchange based on the DEM protocol. Databases in battlefield analytics

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering, geodesy and transport

Lp.	Item Name	Curriculum content
1.	Safety and reliability of building structures	Knowledge in the field of safety and reliability of building structures. Classifications and rules for shaping the load-bearing structures of buildings and the conditions for assessing their safety. Methods of description and distribution of random variables. Functions of reliability and damage intensity. Methodology for conducting reliability tests, risk assessment, the safety of building maintenance and their effectiveness.
2.	Dynamic interaction of building structures with a soil medium	Methods of formulating computational models of the dynamics of structural elements and systems as well as the soil foundation medium of the building. Determination of the physical characteristics of the soil medium under static and dynamic loads. Influence of the content of the phases on the parameters of the substrate.
3.	Environmental physics	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits. Types of light sources for lighting. Indoor and outdoor illumination, luminous flux, illuminance, luminous efficacy, light source spectrum, standard observer, objective determination of the source color.
4.	Modeling of thermal and humidity processes	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
5.	Identification of loads and structural systems	Identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of the initiating reactions of the supporting systems of objects, which are revealed by static or dynamic displacements or vibration frequencies.
6.	Investment process in the construction industry	Organization of construction investments, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
7.	Mechanics of road and airport runway soil foundations	Modeling of the soil as a single-phase or three-phase continuum depending on the type of soil (cohesive or no-cohesive). Stiffness and load carrying capacity of the ground as the problem of an elastic half-space. Dynamic effects generated by moving loads.
8.	Pavement Stiffness and Load-Bearing Capacity Test Methods road and airport	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
9.	Design methods for folding bridge structures	Construction of folding bridges with determination of their technical and operational parameters. Theory of Calculation of Folding Bridges Taking into Account Mounting Clearances for Objects in Static and Dynamic Systems.

Lp.	Item Name	Curriculum content
10.	Design methods of the experiment	The essence of experimental research. Resistance extensometry. Measurements and analysis of measurement errors. Organization of the measurement line. Experimental methods of testing materials in simple stress conditions - tensile, compression, shear, bend, torsion tests. Materials testing in complex stress states. Assessment of rheological properties of materials - creep and relaxation. Optical research methods in mechanics – elastooptics, optical, mesh and holographic interferometry.
11.	Modeling the behavior of elements and structures reinforced concrete	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
12.	Geometric and physical nonlinearities in mechanics Design	Deformations of flaccid structures and bodies with low rigidity, the use of geometric relationships with linear and nonlinear terms. Consequences of deformation in equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.
13.	Explosive effects on defensive structures	Physics of phenomena generated by explosion of explosive charges and fuel-air mixtures. Methods of determining the parameters of explosion loads. Types of mechanisms destroying elements and load-bearing structures of buildings.
14.	Scheduling and costing systems for construction works	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
15.	Engineering of building materials	Contemporary trends in the modification of building, construction and finishing materials. Technologies of preparation, implementation and optimal procedures for incorporating materials and products under building conditions. Structure and material considerations of composites used in construction. The role of additives and admixtures in buildings technologies.
16.	Cartographic methods of research	The use of maps to describe, analyze and scientifically learn phenomena, including cartometric research, mathematical and statistical analysis and methods of mathematical theory of information. Issues related to, among others, distribution analyses (potential maps, concentration analyses), dynamics of phenomena, as well as correlation methods and trend methods.
17.	Spatial data exploration	Review of exploratory data analysis methods with particular emphasis on geospatial data, including classification and grouping, reduction of the number of variables, and spatial pattern discovery. Classification using decision trees and the Byesian classifier, hierarchical grouping, and quality evaluation of classifiers and model validation.
18.	Data science in geospatial research	Advanced geospatial data processing, analysis, and modeling. Searching for trends and dependencies using exploratory data analysis techniques, machine learning and artificial intelligence, m.in.: real estate market, land cover changes, population distribution. The quality of the data and its impact on the effect of forecasting and modeling, as well as effective reporting and visualization of results.
19.	Advanced methods of implementation of studies photogrammetric	Problems of filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF. Fundamental problems of contemporary digital photogrammetry. Digital image acquisition systems – photogrammetric digital cameras and VHRS and Nano satellite systems. Remote sensing and photogrammetric methods of data acquisition. Modern photogrammetric technologies – their applications in the development of site and elevation maps, digital terrain model and orthophotomaps, as well as 3D spatial maps. Application of Computational Intelligence Algorithms in contemporary photogrammetric studies. Characteristics of new multi-image fitting methods. Methodology for developing dense point clouds from images.
20.	Programming in spatial information systems	The use of the programming environment, the concept of procedure, function and instructions for data processing. A way of accessing and processing spatial data directly using programming code. Libraries that enable spatial data processing in the .NET environment, the ability to automate the ArcGIS environment using Python.

Lp.	Item Name	Curriculum content
21.	Reference systems in geosciences	We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference. To be understood in context, when the motion of the Earth's crust is observed, it must be referenced. The global geodetic frame of reference is the fundamental basis for measuring worldwide processes and is crucial for its proper interpretation especially for climatic studies. A terrestrial reference frame provides a set of coordinates of some points located on the Earth's surface. It can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space. This rotation is assessed with respect to a frame tied to stellar objects, called a celestial reference frame. The Earth Orientation Parameters (EOPs) connect these two frames together. Nowadays, four main geodetic techniques are used to compute accurate coordinates: the GPS (Global Positioning System), VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite). They all use networks of stations located on sites covering the whole Earth. Modern realizations are of kinematic type, which means that they include station positions and velocities. They model secular Earth's crust changes that is why they can be used to compare observations from different epochs. The Ph.D. students will learn about advancements of the International Terrestrial Reference System (ITRS) which is a World spatial reference system co-rotating with the Earth in its diurnal motion in space for the geodetic, but also astronomical, and geophysical communities.
22.	Global Geodetic Observing System	Global Geodetic Observing System (GGOS) is the Observing System of the International Association of Geodesy (IAG). GGOS and its related research and services address the relevant science issues related to geodesy, geodynamics and geophysics in the 21st century, but also issues relevant to society, like global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea level estimations and ocean forecasting, or the space weather. The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS mission is to: (i) provide the observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, (ii) provide the global geodetic frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications, and (iii) benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built. Within this subject Ph.D. students will advance their understanding of the dynamic Earth system by quantifying our planet's changes in space and time and learn about the integration within the geodetic, geodynamic and geophysical communities at the highest level, in service to the technical community and society as a whole.
23.	Modern photogrammetric techniques	A modern approach to photogrammetric studies based on the use of the latest techniques of processing imagery obtained from various altitudes and the use of their geometric relationships in the field of situational and elevation measurement in areas including: development and updating of maps, feeding topographic databases, supporting the construction of 3D cadastre, as well as cooperation with mobile systems in the field of building virtual reality at various levels of detail.
24.	Selected numerical methods in geodesy	Practical use of numerical methods to solve scientific and technical problems (geodesy), ideas and concepts of numerical methods, numerical algorithms, programming elements - computational scripts. Use of selected tool libraries of scripting languages such as Matlab, Octave and Scilab.
25.	Methods of parallel data processing	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods and functions of the Parallel Computing and MATLAB Distributed Computing Server Toolbox modules.
26.	Mathematical foundations of digital image processing	Creating gradient and edge filter masks based on differential diagrams constructed using the finite difference method (FDM) and the finite element method (FEM) (convergence, agreement, order of precision, π- as the first form of differential approximation). Spectral properties of masks (matrices of the third and fifth order), including the spectral transfer function and its graphical presentation. The goodness of the mask is defined as the quotient of the spectral transfer function of the filter under study and the visual transfer function of the differential transfer of

Lp.	Item Name	Curriculum content
		the Laplace operator. Operations on masks (addition, subtraction, 45° rotation), determining the form of the differential operator related to the results of these transformations (Laplacian, bi-Laplacian, etc.). Filters that identify only corners (vertices). Bi-Laplacian mask vs. Harris corner detector.
27.	Numerical methods with linear algebra	Vector norm, matrix norm, induced norm. Norm 1, 2 and maximum. Matrix conditioning indicator. The use of linear algebra methods in numerical (differential) solving of mathematical physics problems (advection equation, diffusion, diffusion problem with advection). Convergence and stability of the differential method. Spectral transfer operator. π- a form of the first differential approximation. Numerical diffusion, creation. Analysis of selected differential schemes in terms of spectral properties – explicit, implicit, semi-implicit scheme, Crakn-Nicholson, Crank-Nicholson-Galerkin. Dissipation and dispersion in Lax-Wendroff and Beam-Warming schemes used in civil engineering and trance-sport.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

No.	Item name	Curriculum content
1.	Structural studies by X-ray diffraction	Basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	Structural studies by scanning microscopy	Terms used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Preparation used in reflection and transmission electron microscopy. Selected by advanced microscopic methods (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of images and breakthroughs).
3.	Mechanical Properties Testing of Engineering Plastics	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	Physical Basis of Electro-Optical Effects in Liquid Crystals	Physical basis of electro-optical effects in Liquid Crystals (CK). Selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals.
5.	Calorimetric, thermogravimetric and volumetric methods for testing material properties	Study of materials, in particular materials for storing hydrogen in the solid phase, using: differential calorimetry, thermogravimetry and volumetric analyses. Types of equipment, principles of operation, calibration methods, good practices of use, advantages, disadvantages, possibilities and limitations. Basics of analysis of test results, correction of results and selection of test parameters to obtain the best results.
6.	Semiconductor materials for optoelectronic applications	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic semiconductors).
7.	Nano and ultracrystalline engineering materials	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	Nanoporous anodic aluminum oxide: synthesis, Design & Applications	Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.). Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electrochemical synthesis (temperature, voltage, time). The process of self-organization of the matrix pores into a hexagonal system. Soft anodization. Hard anodization. Pulsed anodization. Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods). Applications of anodic aluminum oxide matrix (biosensors, filters, optoelectronic components, tissue engineering, etc.). New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	Non-telecommunications applications of fiber optics	Interference (phase) fiber optic sensor technology. Terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the definition of the role of the transducer as well as optical and electronic signal processing. Methods of building sensors with a point and a distributed detection field. Multiplication of point sensors.

No.	Item name	Curriculum content
10.	Measurements of machine and equipment parts with using coordinate measuring techniques	Use coordinate measuring techniques and tactile profilometry at various stages of the production process. Metrological properties of coordinate measuring machines and tactile profilometers Programming of a multi-sensor measuring machine to carry out measurements as part of the final acceptance of machine parts and equipment manufactured in mass production conditions.
11.	Experiment planning and data analysis with using Origin and Statistica	The use of computer programs to plan an experiment. Statistical methods. Origin and Statistica's capabilities for experiment planning and data analysis.
12.	Basic properties of liquid crystals	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	Keysight Vee and Lab View in Control and data processing	Basics of programming in LabView, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops (for loop, while), selection structures, feedback, etc. How to use objects of various types (numeric, string, bool), including in the form of matrices and clusters. Methods of data processing and transfer. Creating a program algorithm to control a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Basics of programming in Keysight Vee, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops, selection structures, conditional statements, etc. A way of using objects of various types, including matrices and complex variables. Basic methods of data processing and transfer. Cooperation Keysight Vee – MS Excel. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	Designing technological processes for incremental Direct Deposition methods	Design of elements of machine and equipment parts using solid and surface modeling. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological process design - production of the target production series
15.	Dielectric spectroscopy	Dielectric spectroscopy (impedance spectroscopy/radio range spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics for the analysis of the properties of materials used in electronics. Electrical phenomena at the atomic, molecular, and macroscopic (medium) levels. Theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. Parasitic effects in impedance measurements. Research equipment (impedance analyzers), experiment and analysis of experimental data in the context of the properties of various materials.
16.	Structural Determinants of Material Properties	Terminology, methodology, critical reception of external data, critical evaluation of the results of solving scientific problems in the area of materials and technology. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions.
17.	Modern methods of material characterization	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.
18.	Contemporary information imaging systems and directions of their development	Modern imaging systems for direct observation: liquid crystal, organic LEDs, microleds, flexible and roll-up displays. Discussion of the effects and materials used. The level of solutions achieved, limitations resulting from the physics of effects, material possibilities, available technology. Projection systems used effects, solutions ranging from cinema systems through didactic systems to micro-projectors. Directions of development of displays and projection systems.

No.	Item name	Curriculum content
		Particular emphasis will be placed on combining knowledge about the physical effects used in the construction of displays, new materials (including nano-structures used in LCDs, OLEDs and microLEDs), and the possibilities of modern technology with compliance with environmental protection requirements.
19.	High-energy ball milling and mechanical synthesis	Issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. Types of ball mills, the principle of their operation, capabilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.
20.	Advanced materials for hydrogen storage	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity hydrogen storage materials. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
21.	Basics of plasmonics and metamaterials	Basic definitions of plasmonics and metamaterials. Physical basics, interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces. Technological conditions for the implementation of metamaterial one-, two- and three-dimensional structures. Physical and technological requirements and limitations for different types of metamaterials, as well as the use of classical technologies for the production of nano- and metamaterials. Methods for simulation of the properties of selected metamaterial and plasmonic structures and methods for characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. Application of metamaterial structures in photonic devices and prospects for the development of nano- and metamaterials with particular emphasis on military applications.
22.	Optoelectronic Imaging and Information Processing Techniques	Colour vision, perception of black-and-white and colour information and the human-display-imaging interdependence, display requirements and ergonomics of various types of imagery. Physical and theoretical basis of the effects used in displays and their determinants. Active displays - fluorescent, plasma, electroluminescent, construction, characteristic parameters, purpose and passive displays - liquid crystal, electrophoretic, structure, parameters and conditions of applications. Segmented and multiplex liquid crystal displays as well as active matrix controlled liquid crystal displays. Projection systems, large-format displays, purpose, advantages, disadvantages. Organic and inorganic materials for displays and characteristics of their properties and elements of display manufacturing technology as well as characteristics of technological processes, methods of control and evaluation of display performance parameters. Methods of three-dimensional imagery, methods of implementation and application, teleimmersion.
23.	Selected Materials and Functional Structures for Photonic Applications	Properties and applications of such materials and structures as: optical glass and polymer substrates for the construction of electro-optical transducers, oxide and organic functional layers used as anti-reflective layers, bandstop and edge filters, transparent conductive organic and inorganic layers, nanomaterials for organic applications, photonic polymers and liquid crystals, including composite structures. Construction, construction and operation of selected photonic elements, made on the basis of, among others. the above-mentioned functional materials; spatial light modulator, dynamic wave plates, dynamic elements of diffraction optics (diffraction gratings), optical vortices, microlasers based on self-organizing structures, Kerr and Pockels cells, optical materials and elements for spatial imaging and others.
24.	Computer Image Analysis in Materials Science	Basics of stereology, including basic assumptions and stereological implementations. Detection methods and binarization procedures necessary for quantitative image analysis. Fundamentals of image acquisition and processing (m.in. morphological transformations, logical and arithmetic operations). Procedures carried out during computer image analysis in the study of real engineering materials.
25.	Additive manufacturing of functional materials	Practical aspects of additive manufacturing of functional metallic materials using LMD/LENS laser technology. Influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of functional materials.
26.	Methods for amplifying light emission from broadband	Basic types of broadband semiconductors. Properties of luminescent broadband semiconductors on specific examples (e.g. GaN, ZnO, SnO2). Methods of synthesis of nanostructures. Modulation of optical properties of nanostructures at the synthesis stage. Post-synthetic methods of luminescence enhancement.

No.	Item name	Curriculum content
	semiconductor nanostructures	Intentional doping of broadband semiconductors. The phenomenon of charge and energy transfer. The phenomenon of surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR). Plasmonic light gain from semiconductor nanostructures – basic criteria for coupling SPR or LSPR to the frequency of optical transitions in semiconductors at the metal/semiconductor interface.
27.	Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals	Basic knowledge of the production of porous anodic aluminum oxide (AAO). Parameters of electrochemical synthesis. The phenomenon of constructive and destructive interference. Single-layer and multi-layer interference. Features of an ideal anti-reflection coating. Anti-reflective coatings with gradient refractive index. Microstructure of the moth eye. Surface wettability. High-energy vs. low-energy surfaces. Hysteresis of the contact angle. Wetting textured surfaces: Wenzel model vs. Cassie-Baxter model. General characteristics of 1D, 2D and 3D photonic crystals. Structural coloration. Inspirations drawn from nature, or what is biomimetics. Multi-step electrochemical synthesis of AAO with conical pore shapes. Electrochemical production of 1D crystals by pulsed method. Design of voltage or current pulse sequences, taking into account processes limited by diffusion and the speed of ion transport through the barrier layer. Control of electrochemical synthesis parameters to obtain the desired photonic properties of AAO-based photonic crystals.
28.	Modeling of semiconductor devices.	The genesis of transport equations derived on the basis of the principles of behavior and postulates of thermodynamics of irreversible processes. Generation-recombination mechanisms responsible for the magnitude of charge carrier concentration. Contribution of cross-band processes and SHR mechanisms involving point defects, dislocations and surface states. Process modeling and determination of cross-sections. Mechanism of interband absorption of radiation. Construction of iterative diagrams enabling numerical solving of a system of transport equations. Record on the numeric grid. Problems related to numerical solving of nonlinear equations. He will be able to write a fragment of the program as a task to pass the subject. This fragment can be implemented into my program in order to design a specific device or to study the physical parameters of the structure.
29.	High-entropy alloys – synthesis, structure, research and properties	The latest group of materials – the so-called high-entropy alloys. Theoretical aspects of their formation and stability, properties, structure, synthesis methods and heat treatment. Practical attempts to synthesize and study the properties of alloys from this group.
30.	Additive manufacturing of phased alloys intermetallic	Specific aspects related to the additive manufacturing of alloys based on intermetallic phases (in particular FeAl). The influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of these materials.
31.	Combinatorial Materials Manufacturing and Testing Engineering	Possibilities of using DED laser additive techniques for combinatorial search for new engineering materials. As part of the course, attempts will be made to synthesize both continuous and discrete alloy libraries and the possibility of their rapid study.
32.	Reactive mechanical grinding as a method for the synthesis of modern hydrogen storage materials in the solid phase.	Synthesis of solid-phase hydrogen storage materials using reactive hydrogen grinding in ball mills. Attempts at the synthesis of selected metal hydrides and complex hydrides and studies of the influence of synthesis conditions on its result and the properties of the produced material.
33.	Additive techniques with elements of reverse engineering	Devices used in reverse engineering. Editing and processing of point clouds and generation of STL files, taking into account technological specifics. Preparation for 3D printing (model positioning, material selection, degree of infill, division into layers, source code generation). Multi-variant production of models with complex geometry using FDM and SLA techniques. "Post-processing" and assessment of the quality of the obtained printouts using a 3D scanner and a micro-computed tomography.
34.	Overview of additive techniques used in modern technology	The idea, technical solutions and development trends of 3D printing. Overview of additive methods used in strategic industries – material, technological and economic conditions. Specifics of the processing of high-strength thermoplastics used in aviation and medicine – devices, technological parameters of 3D printing. Evaluation of the geometric and metallurgical quality of sample parts of printed

No.	Item name	Curriculum content
		machines using various additive techniques. Additive technologies and Industry 4.0.
35.	Selected issues in 3D printing	Analysis of the possibility of manufacturing structural elements using Rapid Manufacturing techniques. Specificity of processing advanced construction materials using laser additive forming methods. Material tests and assessment of geometric quality of printouts. Traditional vs. laser methods of regeneration of machine and equipment parts. Analysis of the possibility of reconstructing the operating indicators of machine and equipment parts using the semi-industrial LENS system – multi-criteria quality assessment.
36.	Researcher's workshop 1 – tools for writing scientific texts	The course introduces the doctoral student to issues related to the basic methods of creating texts describing the results of research work, including advanced use of the functions of the following programs: MS Word, LATEX, ENDNOTE, MENDELEY and practical ways of creating drawings, tables and citations. In addition, doctoral students are familiarized with the methodology of selecting the right journal and practical tips when sending manuscripts for publication in prestigious journals.
37.	Researcher's workshop 2 – writing scientific articles	The course introduces the doctoral student to issues related to the basic methods of designing the content of scientific articles, the vocabulary used, methods of graphic processing of results and the use of software helpful in the creation of scientific texts. In addition, the methods of literature analysis, the ethics of creating scientific texts and the selection of authors, the basis of the methodology for processing the results, as well as the possibilities of using software and services for linguistically correcting scientific texts will be presented.
38.	Researcher's Workshop 3 – Writing Scientific Articles	The subject introduces the doctoral student to issues related to the estimation of measurement uncertainty in scientific papers. The issues raised during the classes are focused on learning practical methods of determining uncertainty in real measurements. Theoretical aspects, i.e. the mathematical apparatus used in estimating uncertainty, is reduced to the necessary minimum. Part of the classes is intended to solve the issues reported by doctoral students.
39.	Quantum mechanics in examples	The course aims to solve in detail and analyze the most important examples describing the behavior of particles in the microworld in the language of quantum mechanics. After the introduction to wave mechanics, the following examples will be analyzed: free particle; transmission (reflection) through the potential threshold; transmission (reflection) through the potential barrier (tunnel effect); an infinite pit of potential; a finite pit of potential; harmonic oscillator; the Krönig-Penney model; solving the problem of the Coulomb potential.
40.	Corrosion testing in materials science	Corrosion phenomenon and mechanisms of various types of electrochemical and chemical corrosion, thermodynamic determinants of corrosion phenomena: corrosion vs. passivity – Pourbaix diagrams, qualitative and quantitative methods in corrosion tests – review, polarization and polarization curve with its characteristic points and ranges, determination of corrosion current potential and density from extrapolation by the Tafel equation, chronoamperometry and determination of the initiation and propagation time of pitting in corrosion Basics of electrochemical impedance spectroscopy: equivalent circuits and real elements of materials and coatings, salt chambers, immersion tests.
41.	Anodic oxides of copper and its alloys – production, characteristics and applications	Synthesis and mechanism of growth of passive layers on copper, review of the methods and experimental conditions used for the production of copper oxides and hydroxides by electrochemical means, thermodynamic conditions allowing the growth of oxides and hydroxides, redeposition and growth of layers, modifications of copper oxides and hydroxides, applications of nanostructured copper oxides and hydroxides: corrosion protection, photocatalysis, electrochemical reduction of carbon dioxide to alcohols and Hydrocarbons.
42.	Anodizing of aluminum alloys	Structure and mechanical properties of alloys vs. corrosion resistance, corrosion failure mechanisms of common aluminum alloys, overview of industrial anodizing methods, conversion coatings vs. anodic coatings, soft, hard and plasma anodizing (PEO/MAO), hexavalent chromium problem, chromium-free alternatives used in anodizing aluminum alloys, nanoporous oxide and corrosion protection, pore closure, REACH convention vs. anodizing and pore closure, durability of anodic aluminum oxide on technical alloys, methods of quantitative treatment of corrosion of aluminum alloys after anodizing.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

No.	Item Name	Curriculum content
1.	Numerical Analyses in Load-Bearing Structures	Theoretical foundations of numerical methods of analysis of load-bearing structures including multi-stage analyses, strategy of computer FEM simulation of two- and three-dimensional problems in the field of mechanics and strength of materials and methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphics preprocessors. Construction of 2D and 3D models for analysis in the field of selected engineering issues, performance of calculations with attention to the selection of optimal analysis parameters and assessment of the correctness of calculation results using analytical methods and available results of experimental tests, on the example of elements and components of vehicles, special and load-bearing structures.
2.	Autonomy of mobile robots	Introduction, definitions, components of the construction of mobile robots. Wheeled robot drive systems. Navigation and self-location of robots. Navigation with the use of markers. Odometry, methods to improve self-localization results. Determining the position of the robot based on the map. Methods of planning the path of a mobile robot. Local planning, probabilistic methods. Tasks, construction, architecture of control systems Vision systems in mobile robotics. Walking robots. Applications of autonomous mobile robots.
3.	Non-destructive testing of aircraft	Types of defects, defects and damage that threaten the safety of operation of technical facilities. Non-destructive testing methods – physical basis. Visual and penetrative methods. Ultrasound method. Acoustic methods. Eddy current method. Thermographic method. X-ray method. Shearograps and DSight. Non-destructive testing methods – advantages, disadvantages and limitations in use. Non-destructive testing certification.
4.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of a human body model and experimental research. Calculating the risk of injury to the head, torso and thighs. Injury risk prediction models.
5.	Construction and operation of industrial robots	Construction and operation principle of industrial robots. Principles of robotization of production lines. Environments and languages for programming industrial robots
6.	Digital signal processing	Mathematical models of deterministic signals. Advanced signal sampling techniques. Selected problems of analysis of discrete signals in the time and frequency domain. Frequency resolution of digital spectral analysis algorithms. Fast weave algorithm. Selected specialized implementations of digital filters. Basics of digital filter design. Decimation and interpolation of digital signals. Digital signal spectrum conversion. Direct Digital Signal Generation Method (DDS). Program receiver.
7.	Dynamics of mechatronic system design	Issues of modeling mechatronic systems. Elements of motion and vibration analysis of linear systems with single and multiple degrees of freedom. Elements of motion analysis of nonlinear mechatronic systems. Stability testing of linear and nonlinear mechatronic systems. Self-excited vibrations. Methods of measuring vibrations of mechatronic systems.
8.	Dynamics of car movement	Modeling the movement of the car. Modeling of movement on hard, snowy and deformable surfaces. Analysis of the dynamics of rectilinear and curvilinear motion. Steerability and stability. Overcoming terrain obstacles. Wheeled and tracked chassis. Modeling the process of a car crashing into an obstacle. Analysis of vibrations and driving comfort.
9.	Dynamics and modeling of hydrostatic systems	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis and its description. Modeling of hydrostatic drive assemblies, subassemblies, elements and systems. Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
10.	Dynamics of multi-member systems	Theoretical foundations of numerical methods of analysis with the use of rigid bodies and the strategy of computer simulation of multibodies with the use of

No.	Item Name	Curriculum content
		various algorithms for the formulation of equations of motion and their integration. Overview of multibody analysis software environments and examples of mechanical engineering solutions. Methods of modeling mechanical structures with rigid solids in planar and spatial systems. Construction of planar and spatial models with the use of various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected issues of mechanical engineering. Multivariant numerical analyses with attention to the selection of optimal calculation parameters and the assessment of the correctness of the obtained results using analytical and experimental methods.
11.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
12.	Computer-aided operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
13.	Shaping a safe car body	Body construction - shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
14.	Composite materials in mechanical engineering	Definition and classification of composite materials. Strength and performance properties of composite materials. Technologies for the production of composite materials. Research used in the experimental analysis of mechanical properties of composites. Joining composite materials. Metal-composite joints. Exploitation of composite materials. Repairs of composite structures.
15.	Finite Element Method	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
16.	Methods of analysis of numerical experimental research results	Selected deterministic and stochastic examples in the research methodology allowing the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
17.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
18.	Experimental methods for investigating the thermophysical properties of solids	Thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
19.	Methods and techniques for testing the mechanical properties of materials	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring deformations during strength tests. Methods of testing the mechanical properties of materials under shock loading conditions. (Hopkinson test, Taylor test, ring test).
20.	Numerical Methods in Engineering Applications	Basic concepts related to numerical calculations, sources of errors. Interpolation and approximation. Differentiation and quadrature. Systems of linear equations. Algebraic eigenproblem. Methods of solving ordinary differential equations. The linear problem of least squares. Fourier analysis. Optimization elements. Information about other areas of numerical analysis (partial differential equations, stochastic methods, etc.).

No.	Item Name	Curriculum content
21.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
22.	Methods for designing and optimizing aircraft structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission modeling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
23.	Constitutive Models of Materials in FEM Analysis	Mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. Experimental studies to determine the parameters of models. Numerical analyses using learned material models.
24.	Modelling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software
25.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
26.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
27.	Parametric modeling and structural optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
28.	Flow modeling	Methods of computer modeling of flow processes in basic and applied problems of fluid motion dynamics. Simulation methods for researching streamlined issues. Basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver. Modeling of flow turbulence, including averaged Navier-Stokes equations, turbulent stress tensor, turbulence modeling capabilities and problems. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES). Mapping of complex simulation study objects, construction and execution of basic operations on computational grids, analysis of the reliability and accuracy of numerical modeling results.
29.	Modeling machine motion	General principles of modeling mechanical systems. hydrostatic, electromechanical. Deterministic and random processes. Construction of simulation models. Identification of model parameters and their validation. Characteristics of basic dynamic members. Basics of dynamics of systems with variable mass.
30.	Modeling composite structures	The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.
31.	Modeling of the Contact Phenomenon in Structural Mechanics	General division of contact phenomena. Mathematical foundations of the description and solution of the problem of contact. Algorithms for defining and

No.	Item Name	Curriculum content
		solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
32.	Modeling and research of the processes of cooperation between the wheel and the road	Issues of modeling and testing the processes of cooperation between the wheel and the road to the extent necessary to model the dynamics of vehicle motion (selected mathematical models, methods and techniques of testing tire wheels on a drum stand and with the use of a test trailer).
33.	Modeling of car traffic and controls	Review of vehicle motion dynamics models and models describing the driver-vehicle-road system (models of lateral dynamics of the car in various control configurations).
34.	Modern technologies for bonding structural materials	Friction stir welding (FSW), laser beam welding (LBW), areas of application and strength properties of the cohesive joints obtained. Influence of bonding processes on the microstructure of selected construction materials. Heat and mechanical treatment of FSW and LBW cohesive joints.
35.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
36.	Renewable energy sources	The importance of energy in the development of modern civilization. Modern fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
37.	CAE Engineering Software	An overview of CAE engineering support systems with an indication of their purpose and the possibility of using them in structural analyses. Preparation of numerical models for calculations in the static and dynamic range. Running calculations and presenting and processing the results obtained.
38.	Experiment planning and optimization of mechanical objects	Introduction to planning an experiment. Measurement errors and uncertainties. Characteristics of random variables. Statistical hypotheses and their verification. Correlation and regression analysis. Plan your experiment. Two-level plans. Three-level plans. Multi-level plans. Simplex plans for analysis composition – property. Criteria for the optimality of plans. Optimization of Extreme Machine Technology of Statistical Functions and Their Limitations. Methods of determining the extremum of statistical functions. Examples of experiment optimization in mechanical engineering.
39.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Safety in the movement of autonomous vehicles. Statistics of road accidents and their interpretation.
40.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
41.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.
42.	Fundamentals of Mechanics of Continuous Media	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.
43.	LabVIEW environment in experimental research	The process of creating programs in the LABVIEW environment with the use of control and measurement equipment (myRIO, sbRIO, DAQmx). Data types in LABVIEW. Complex data types in LABVIEW, Communication with measuring devices in LABVIEW. Analysis of measurement results.

No.	Item Name	Curriculum content
44.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.
45.	Programming of control systems for unmanned working machines and robots	Introduction to the UML standard. Build relational schemas and use case schemas. Creation of control algorithms. Introduction to programming, programming devices for hydrotronic applications. Design a feedback loop. Implementation of feedback loops in control systems.
46.	Mechatronic sensors	Mathematical models of mechatronic sensors. General principles of mechatronic sensors. Methods of measurement, errors and methods of calibration of sensors.
47.	Condition monitoring systems	Sensors used in condition monitoring. Resistance strain gauge. Fiber optic sensors. Crack sensors. Data transmission. Recording and analysis of measurement data. Inference. Coupling of condition monitoring systems with the operating system and the operation system.
48.	Aircraft Operation Systems	Principles of operation and repair of military aircraft in the Republic of Poland. Harmonized European Military Airworthiness Regulations (EMAR). European Airworthiness Regulations (PART). The role of EASA and the Civil Aviation Authority in supervising the operation of aircraft. Bulletins and other documents regulating the operation.
49.	Control systems in mechanical engineering	Advanced control systems for mobile machines. Machine control system functions. Types of control systems. Development trends of sensors used in mobile machines. Vision and lidar locating and navigation systems. Satellite systems in machine control Centralized and distributed control. Intelligent communication networks. PLC control. Fuzzy logic in machine control
50.	Technologies for the production and processing of composite materials	Composites, ways of defining them, types of components that make them up, the most important methods of their production and processing, the importance of this class of materials in mechanical engineering. The structure of modern composite materials depending on the method of production and the treatment used, e.g. heat, thermo-plastic. Manufacture of ceramic matrix composites and multilayer metallic composites and achievements in the use of composites.
51.	Selected solutions in the field of automotive technology and car motion	Problems of the development of automotive technology and road traffic. Concepts of intelligent transport systems. Selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs, lighting systems). Driver assistance systems. Self-driving cars.
52.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
53.	Thermomechanics of materials and studies of thermophysical properties	Phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and presentation of selected issues of statistical description of these phenomena to explain the nature of thermo-physical properties. Heat transfer phenomena in materials and material structures. Material properties vs. resultant and apparent properties of material structures. Methodology of testing thermo-physical properties. Thermal Analysis Methods. Methods for determining specific heat, thermal conductivity, thermal diffusivity, thermal expansion of materials and material structures.
54.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.
55.	Durability of aircraft structures	Methods for determining and testing aircraft durability. Concepts of aircraft operation, factors limiting the durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the

No.	Item Name	Curriculum content
		durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in aircraft operation. Corrosion of aircraft.
56.	Introduction to the equations of mathematical physics	Formulation of mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. General principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics. The method of reducing borderline issues to a dimensionless form is discussed. Formulation of mathematical models based on mathematical physics equations.
57.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
58.	Modern test methods for internal combustion engines and vehicles	Identification of the purpose of research. Selection of the test method. Validation of research methods and procedures. Approval test procedure. Selected methods of homologation tests, measuring equipment. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty Analysis and presentation of research results. Calibration of measurement systems. Practical implementation of selected research methods.
59.	Selected methods and techniques of temperature measurement	Theoretical basics of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. Types of thermometers: liquid, thermoelectric, resistive, thermistor, quartz, bimetallic, radiation, fiber optic and thermal imaging cameras. Statistical processing of measurement results
60.	Selected problems of rocket technology	Mathematical models of physical processes related to the dynamics of rocket motion. General rules for building rockets. Construction of rocket compartments with mathematical models. Computer simulation and visualization of the rocket flight path. Overloading of rockets on the flight path.
61.	Selected issues of waste gas treatment from motor vehicles	The impact of the automotive industry is influenced by the natural environment. Characterization of harmful substances. Systems and methods of motor vehicle waste gas treatment. Development tendencies in flue gas cleaning methods. Test methods and equipment for testing waste gases from internal combustion engines and vehicles. Studies on the influence of the operating condition of an internal combustion engine on the emissions of individual exhaust components and the granulometric composition of particulate matter.
62.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	Simulation tasks. Selection of the simulation method. Selected models of the work cycle of an internal combustion engine. Workflow simulation software. Procedure for simulating selected routings. Analysis and presentation of simulation results. Evaluation of simulation results. Simulation of selected working processes of internal combustion engines.
63.	Selected issues of modern programming - introduction to modern programming languages.	Introduction to programming using high-level languages. The issue of structural and object-oriented programming. Introduction to Python with basic libraries and the PyCharm environment. Creating console programs using Python. Introduction to creating GUI programs.
64.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Application of the principles of fatigue strength of materials and fracture mechanics. Fatigue test methodologies and fatigue testing equipment. Crack development due to cyclic loads. Fatigue crack growth characteristics. Methods for evaluating the strength of cracked components
65.	Advanced methods of manufacturing products from sintered powders	Manufacturing processes of machine parts using modern methods of manufacturing engineering, including powder metallurgy.
66.	Advanced ballistics, modeling, and simulation	Development trends in the field of solid propellants and propellant systems (theoretical basis for modeling the operation of atypical propellant systems from the point of view of internal ballistics). Outflow of powder gases from the barrel during firing and their flow through the muzzle brake (description of the phenomena occurring during the outflow of gunpowder gases from the barrel during firing -

No.	Item Name	Curriculum content
		transitional ballistics). Geometrical, mass-inertial and aerodynamic characteristics of missiles and rockets (theoretical basis for modeling the motion of flying objects from the point of view of external ballistics). Modeling of the impact impact of objects (theoretical foundations for analytical and numerical modeling of phenomena that are the domain of final ballistics).
67.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
68.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
69.	Advanced measurement systems	Structure and organization of computer-controlled measurement systems and with procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. Programming basics and how to use virtual instruments to collect, collect and process measurement data.
70.	Advanced Materials Testing Methods	Methods of testing materials, possibilities and limitations of various test methods based on the use of specialized equipment. Modern electron microscopy, confocal microscopy and X-ray microanalysis (qualitative and quantitative) and their practical application in mechanical engineering. Methods for investigating the macro- and microstructure of metals, their alloys and ceramic materials, and interpreting the test results obtained by various materials testing methods. Topographic contrast and its use for fractography studies, evaluation of changes in the microstructure of materials as a result of treatments, studies of powders and thin surface films. Microanalysis of phases and inclusions in materials research. Testing of material heterogeneity. Trace analysis of elements. Light microscopy in materials research. Metallography. Image analysis. Electron beam and its properties. Electron diffraction. Structure of a scanning and transmission electron microscope.
71.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
72.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
73.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	Issues related to wave propagation (elastic, plastic). Mathematical description of the phenomenon of mechanical wave propagation. Boundary conditions. Methods to solve the presented issue. Numerical analysis of wave propagation.
74.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force. Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
75.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials. Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.
76.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations - condition index. Gaussian method of numerical solving of a system of linear equations. Direct

No.	Item Name	Curriculum content
		methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Methods of numerical solving of ordinary differential equations.
77.	Electromagnetic field theory	Maxwell's equations; Differential form of Maxwell's equations in material media; Maxwell's equations for harmonically variable fields; Integral form of Maxwell's equations. Electromagnetic waves in an ideal dielectric; TEM type flat wave; Wave impedance and specific impedance. Electromagnetic waves in a lossy medium. Boundary conditions and energy relationships in the electromagnetic field. Power balance in the electromagnetic field in real and complex description. A real, complex and time-average Poynting vector. Wave incident obliquely on the dielectric-dielectric interface; Fresnel formulas for a plane wave falling obliquely on the boundary of two dielectric media. Reflectivity and power transmission. A wave incident perpendicularly at the dielectric-dielectric interface. Determination of reflection coefficients and power transmission for a plane wave incident perpendicularly on the boundary of two dielectric media. Electromagnetic waves in waveguides. Wave Mods. Potentials in electrodynamics and radiation from current sources; Vector and scalar potential. Delayed electromagnetic potentials. Potentials generated by localized sources. Hertz's Dipole.
78.	Quantum mechanics	Wave function and Schrödinger equation. Probabilistic interpretation of the wave function. Probability current density. Expected value. Separation of the wave equation. Quantum Mechanics Formalism; N-dimensional vector space; Space base; Scalar product; Hilbert space; Orthogonality of vectors and systems. Orthonormal bases; Linear operators; Operator equations; Matrix representation of an operator; Hermitian and unitary operators; Dirac notation. Selected solutions of the Schrödinger equation in 1D; A quantum particle in an infinite potential well. A free quantum particle. Uncertainty of Observables - Heisenberg Uncertainty Principles. Eigenvalues and eigenfunctions of a quantum harmonic oscillator. Creation and annihilation operators. Separation of the Schrödinger equation in 3D. Quantum particle in a spherical potential well in 3D. Values and eigenfunctions of the angular momentum operator. The spin theory of the electron. - Pauli matrices. Mutual uncertainty of spin components. Entangled states and non-locality. - The concept of entangled states and qubit. Their role in new quantum technologies.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

No.	Item Name	Curriculum content
1.	Analysis of Chemical Warfare Agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and technology of liquid crystal materials	Molecular structure, structures and textures of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and technology of high-energy materials	Current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels: structural determinants of the stability and sensitivity of explosive compounds; design, fabrication and characterization of nanostructured explosive mixtures; principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; New ways to craft explosive compositions and form them into charges. design, manufacture and characterization of thermobaric explosives; design, synthesis and explosive properties of complex compounds; design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids as well as new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Polymer chemistry	Polymers obtained in the process of polychain reaction. Condensation polymers, polyadducts. Inorganic-organic polymers. Polymers of natural origin. Special-purpose polymers.
5.	Chemical Foundations of Environmental Pollution	Basics of ecology. Man and the environment. Natural resources and ecological factors: temperature, radiation, air, water and soil. Humanity in the face of global challenges. The paradigm of sustainable development. Principles of green chemistry. Air pollution (acid jet, ozone depletion, greenhouse effect, London and Los Angeles smog). Sources of water pollution (municipal, industrial and agricultural pollution). The most important pollutants found in sewage. Pollution of seawater. Water treatment. Soil pollution. Types of harmful effects of human activity on soil: geomechanical, hydrological and chemical transformations, physical and biological degradation. Heavy metals, their characteristics, sources and impact on the environment and human health. Characteristics of cleaning and washing agents (soaps, detergents). Negative effects of using cleaning and washing agents. Organochlorine compounds in the environment (chlorophenols, polychlorinated biphenyls, dioxins). Pesticides. Classification of pesticides and their properties. Chemical structure of pesticides. Pesticide forms. Benefits and problems of pesticide use. Building materials (paints, adhesives, asbestos, products containing formaldehyde, oils) and their impact on the environment and human health. Volatile organic compounds (VOCs). VOC sources. Harmful effects of VOCs in the stratosphere. Pharmaceuticals and personal protective equipment in water. Classification, sources of origin, occurrence and environmental impact of drug residues. Food chemistry. Classification and characteristics of food additives (preservatives, improvers, antioxidants, flavor enhancers, sweeteners, dyes). Dietary supplements.
6.	Physicochemical Properties of Carbon Materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and

No.	Item Name	Curriculum content
		bioactivity of carbon materials. Prospects for the development of new carbon structures and their applications.
7.	Physicochemical aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
8.	History of chemistry	Synthesis of elements in the universe, first observations and chemical achievements of antiquity (alchemy). History of chemical discoveries in the world: physical chemistry, analytical, chemical analysis, organic synthesis, food chemistry. Achievements of chemistry after 1661 (R. Boyl). Development of separation techniques and analysis and their impact on the development of views on chemistry and the structure of chemical compounds. Evolution of nomenclature and symbols of elements and chemical compounds. History of the periodic table, kinetic and thermodynamic studies. The development of chemistry and organic synthesis in the twentieth century and its impact on the emergence of molecular biology.
9.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
10.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
11.	Spectroscopic methods	A subject for doctoral students of disciplines other than chemical sciences. Electron spectroscopy (UV-Vis), vibrational spectroscopy (IR), nuclear magnetic resonance (NMR) spectroscopy, mass spectrometry (MS). The doctoral student can additionally choose spectroscopic methods from the given group of methods: near-infrared spectroscopy (NIR), Raman spectroscopy, oscillation-rotational and rotational spectroscopy, two-dimensional nuclear magnetic resonance spectroscopy (2D NMR), circular dichroism spectroscopy (ECD and VCD), fluorescence spectroscopy.
12.	Modeling and simulation computer programs in chemistry	Fundamentals of Computational Chemistry: Computational Assumptions and Methods. CHEMCAD program organization and basics of use. Application of CHEMCAD in chemical technology and materials engineering. Implementation of a project in the field of chemical technology using the CHEMCAD system. Organization of the SCIGRESS program and basics of use. Optimization of geometry and calculation of physicochemical properties of molecules. Modeling of chemical reactions in the gas phase and solution. Modeling of spectroscopic properties of molecules.
13.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Adsorption of nitrogen and argon as a complete method for determining the specific surface area, porosity and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and

No.	Item Name	Curriculum content
		investigation of adsorption properties of graphene composite materials. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
14.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials
15.	Biomedical polymers and biomaterials	Definition of biomaterials, classification, role of chemical composition, working environment, properties and uses of biomaterials. Metal biomaterials. Ceramic biomaterials. Polymer biomaterials. Carbon and composite biomaterials. Modern polymer and hybrid systems used in biomedicine for diagnostic purposes (e.g. contrasts for magnetic resonance imaging) and therapeutic purposes (e.g. drug carriers).
16.	Practical tools and concepts of modern organic synthesis	An advanced course in organic chemistry with an emphasis on acquiring the ability to plan the syntheses of complex organic compounds. The use of modern organic synthesis techniques. Chemistry of organofluorine compounds. Flow chemistry in organic synthesis. High-pressure organic reactions.
17.	Synthesis of liquid crystals	Introduction to liquid crystals, structure and anisotropic properties. Applications of liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Superfluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
18.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
19.	Advanced pyrotechnics	The latest solutions used in military and civilian pyrotechnics. Currently used reducers, oxidants, binders and modifiers. Pyrotechnic applications of high-nitrogen compounds. Modern compositions of curtain smokes active in the infrared range. Modern multi-base solid rocket fuels. Solutions used in airbag inflators. Prospective applications of pyrotechnic mixtures in medicine. Basic algorithms used in modeling combustion processes and analytical optimization of the composition of pyrotechnic compositions.
20.	Advanced spectroscopic methods	A subject for doctoral students of the discipline of chemical sciences. Expanding the knowledge about basic spectroscopic methods: electron spectroscopy (UV-Vis), vibrational spectroscopy (NIR, IR, Raman), nuclear magnetic resonance spectroscopy (NMR), mass spectrometry (MS). Advanced spectroscopic methods, including time-resolution, two-dimensional, combined techniques.
21.	Application of gas chromatography in physicochemical studies	The essence of interactions in chromatography. Chromatographic mechanisms of test substances in: ideal linear chromatography, ideal nonlinear chromatography, non-ideal linear chromatography, non-ideal nonlinear chromatography. Basic chromatographic quantities. State functions – methods of determining and interpreting thermodynamic functions for solutions whose solvent is a liquid stationary phase. Studies of surface properties and basic surface phenomena by impulse elimination and adsorption studies of gas mixtures. Studies of surface properties and basic surface phenomena. Methods of surface determination and analysis.

Annex VI.7
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security studies

No.	Item Name	Curriculum content
1.	Social research in the sciences Safety	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Non-reactive methods. Desk *research*
2.	Statistical methods in research Social	Population and sample. Statistical features. Measurement scales. Random variables. Normal distribution. Characteristics of qualitative and quantitative characteristics. Nonparametric estimation. Parametric estimation (point and interval). Verification of statistical hypotheses. Diagram of the materiality test. Testing the normality of the distribution. Problems of analysis of the interdependence of phenomena. The research process in the social sciences and the typical structure of scientific work. The course of data collection, analysis and evaluation.
3.	Risk management in security	Risk concept and risk management process. The concept of risk and risk management. Development of the risk management field. Risk management process. Risk measures. Types of risk in the security sector. Risk measurement in public sector entities. Risk measurement in the context of ensuring system continuity.
4.	Management system designs Security	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
5.	Safety Systems Engineering	The place of systems security theory in the family of sciences. Basic concepts of system security (system status, description of system security-related states, system security indicators). Principles of mathematical modeling of system security. Component and subsystem safety. Systems security models. Systems security research. Analysis of system security. Control of safety, systems.
6.	Propedeutyka Security	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies are the "old" and "new" wars in the interpretations of realism and constructivism.
7.	Management strategies and concepts Security state	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal functional factors and ways of defining security in doctrines and strategies (comparative analysis).
8.	Management Crisis in administration Public	Contemporary concepts of crisis management (the concept of vulnerability, the concept of resilience, the concept of adaptation). The subject of crisis management. Legal basis of crisis management in Poland. Crisis management process. Basic types of threats – sources of crisis situations. A crisis situation. Crisis management system in Poland. Effectiveness in crisis management.
9.	Safety Common	The essence of public safety. General security and national security. Mechanisms shaping public safety. Rescue. Civil protection. Civil Defense. Fire protection. Critical infrastructure protection. Organization of the protection of human life and health, material and cultural goods and the natural environment Methods and tools used to ensure public security in Poland and the EU.
10.	Safety Internal	Perception of security. Political determinants of internal security. Institutional system of internal security. Administrative police in the internal security system. Private entities in the organization of internal security. Organization of security in the region. Organization of security in the district. Organization of security in the district.
11.	Data analysis Survey	Creating measurement tools. Sampling. Preliminary analysis. Schedule analysis. Contingency tables, boundary and conditional distributions. Analysis of single-

No.	Item Name	Curriculum content
		choice and multiple-choice questions. Significance and strength of the relationship between nominal and ordinal variables. Hypothesis testing.
12.	Analysis Multidimensional	Methods of graphical presentation of multidimensional data. Multiple regression analysis. Analysis of canonical correlations. Principal components analysis. Exploratory Factor Analysis (EFA). Multidimensional scaling. Linear ordering. Cluster analysis.
13.	Test procedures Evaluation	The concept of evaluation research. History and institutionalization of evaluation research. Types of evaluation research – the concepts of "impact assessment", "action research". Differentiation of evaluation research in terms of their social functions. Experimental designs in evaluation studies. The Concept of Experimental Society by A. Etioni. Monitoring and evaluation. Elements of cost-benefit analysis in evaluation research. Measurement problems in evaluation research.
14.	The theory is logical Argument	Logical argumentation. Deductive, reductive and inductive inferences. Diagrams and argumentation diagrams. Recognizing arguments. Diagram. Classified premises and conclusions. Elements of the evaluation of argumentation. Acceptability of premises. Reliability of sources. Relevance.
15.	Forecasting and simulations in security	Forecasting and social practice. Social premises for predicting behavior. Forecast vs. decision-making. Model methods. Extrapolation of trends. Validity, admissibility and error of the forecast. Forecasting based on time series. Forecasting based on econometric models. Heuristic forecasting models. Social simulations.
16.	Modern technology in security	Know-how, modern technologies and their importance in ensuring safety. Modern technologies in the defense and protection system. Modern technologies in the economic security system of the state. Modern technologies in the social security system. The use of modern safety technologies in electricity generation, in the transport system, in the protection of critical infrastructure, in the protection of the natural environment.
17.	Philosophy of Sciences Safety	Origins, subject and branches of philosophy and philosophy of security as the most general knowledge about security. The genesis and types of human knowledge in philosophical discourse (sources: mystical, intuitive, philosophical and scientific; types: scientific, theoretical, practical and intuitive). The logic of scientific discovery, revolution in science and the progress of knowledge in the view of contemporary epistemology. Semantic analytics of the name security and types of its understanding – the essence of security in philosophical terms. A natural and conventional concept of security. Materialistic, idealistic and realistic concepts in the hermeneutic anchoring of security. The Praxeological Concept of the Four Simple Acts and Universal Methods of Shaping Security. Tendencies in Broadening, Deepening and Thickening Security Studies The Method of War, Peace, Non-Peace and Non-War in Praxeological Approach. Philosophical problems of security in contemporary societies of control and surveillance from the perspective of dataism and technohumanism.
18.	Modern terrorism	Basic concepts and their meaning. The origins of terrorism. Causes of modern terrorism. The main factors generating and escalating terrorism. Systematization of the causes of terrorism. A triad of terrorist motivation. Key elements and types of terrorist threat. The scope and nature of terrorism at the beginning of the 21st century. Effects of terrorism. Preventing and combating terrorism.
19.	Morals and culture Security in relationships National and international	The essence and importance of the security culture (KB) and morale (M) of physical and legal entities in internal and international relations. Psychosocial and praxeological models and "mechanisms" of KB and M functioning – relations between them. Safety culture (KB) and morale as types of key resources and competitive advantage factors in "normal" and crisis situations. Security culture as an interface integrating the security areas in question and the national security system (SBN). Intuitive and scientific ways of diagnosing and improving KB and M. Security culture and morale in times of information warfare and asymmetric conflicts
20.	History Security	Military, political and economic security of medieval Polish and the Polish-Lithuanian Commonwealth until its collapse. The main problems of European security in the nineteenth century. Polish national uprisings of the nineteenth century. World War I. Determinants of international security in the interwar period. Military, political, economic and social security of the Republic of Poland (1918–1939). World War II. International security in the second half of the twentieth century. U.S.-USSR relations and their impact on international security. Military, political and economic security of Poland after World War II.

No.	Item Name	Curriculum content
21.	Communication Strategy	Characteristics of strategic communication (terminology, essence, responsibility in NATO). Public diplomacy (terminology, essence, structures). Informing the public (terminology, essence, structures). Information operations (methods, views of NATO, views and structures of the USA, Polish views). Psychological operations (methods and techniques of action, US structures, German structures, Polish structures, British structures).
22.	Political sector Security	Political security. Concepts. Political security in security sciences. Forms and types of political threats as well as determinants and research of political security. A model of institutionalization of political security. The need for citizen security and the tasks of a democratic state. The crisis of civic identity. Power as a factor of security. Security strategy as an instrument of political security. The influence of interest groups on political decisions. Media – shaping public opinion. The basic dilemma of political security.
23.	Shaping Security Military in the 21st century	Characteristics of military security of selected states and associations of states in relation to the methodology of identification and description of challenges, and thus potential opportunities and threats to the existence and development of individual societies. The terminology of military security, the components of this security, the impact of these elements on the state and process of military security in the face of identified and described challenges (opportunities and threats) in the perspective of the current century.
24.	Safety Information	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPauduli, Biby, Shiver-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
25.	The economic dimension of safety	Defining economic security and its dimensions. Economization of state security. Typology of threats to economic security. The state and the national economy in the face of contemporary cultural and civilizational changes. Economic aggression in international relations. Financial crises. Activities of transnational corporations. Technological espionage as a threat to economic security. State activity to ensure economic security.
26.	Safety Energy facing Transformation socio-economic	The impact of socio-economic transformation on the functioning of the energy sector of developing and developed countries, and thus also on the energy security of these countries. A parallel process of influencing the way the energy industry operates, as well as the functioning of the energy security sector to protect the industry against threats (both old and new, generated by current socio-economic changes).
27.	Social Conditions Security modern states	The essence of social security. Social security and the model of the state system. Mechanisms shaping social security. Concepts of social security. Models of social security in the EU. Problems of social security in Poland and ways to overcome them. EU activities for social security.
28.	Combating and corruption prevention	Seminar classes. Threats to state security caused by corruption behaviors. Forms of corruption and the offences associated with them. Legislative activities and services responsible for combating and reducing corruption and the principles of building effective anti-corruption solutions in public organizations and in the private sector.
29.	Operational methods of combating serious criminal crime	Seminar classes. Statutory operational methods, i.e. operational control, covertly supervised shipment, controlled purchase and controlled giving/acceptance of financial benefits, used to combat and prevent serious criminal crime. The rules for granting consent to the use of the indicated tools for combating this type of crime and the use of evidence obtained in this way in criminal proceedings. Methods of controlling the use of such non-procedural measures to ensure state security.
30.	Safety Organic on a global scale regional and national	Types of challenges (opportunities and threats) generated by climate change in the area of environmental security. Identification of the impact of climate change on the national security of selected societies on a national, regional and global scale.

No.	Item Name	Curriculum content
31.	Cultural security factors	Culture: concept, categories, identity. Cultural security: conceptual aspects, cultural security in the area of spiritual culture, security in the area of material culture. Cultural threats to the security of the Republic of Poland. The cultural security system of the Republic of Poland. Cultural aspects of international relations. The Cultural Background of International Conflicts. Security Culture – National and International Aspects

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 9/WAT/2025 of 27 February 2025

on the establishment of the "Curriculum" at the Doctoral School Military University of Technology - 2025 edition"

Pursuant to Article 201(4) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2024, item 1571, as amended), in connection with § 21(1)(21) of the Statute of the Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), the following is resolved:

§ 1

The "Curriculum" **(**Education program} at the Doctoral School of the Military University of Technology - 2025 edition" *is hereby established,* constituting an attachment to the resolution.

§ 2

The curriculum referred to in § 1 is in force from the academic year 2025/2026.

§ 3

Doctoral students of the Doctoral School of the Military University of Technology who started their education before the academic year 2025/2026 may update their Individual Education Programmes on the basis of this program.

§ 4

The resolution shall enter into force on the date of its adoption.

President of the Senate

Gen. bryg. prof. dr hab. inż. Przemysław WACHULAK

Attachment to the resolution of the Senate of the Military
University of Technology No.9/WAT/2025 of 27 February 2025

CURRICULUM

DOCTORAL SCHOOL

MILITARY UNIVERSITY OF TECHNOLOGY

- edition 2025

I. General principles

1. The curriculum (education program) at the Doctoral School of the Military University of Technology is carried out for doctoral students of the following scientific disciplines:
    1) **automation, electronics, electrical engineering and space technologies** - a field of engineering and technical sciences;
    2) **information and communication technology** - a field of engineering and technical sciences;
    3) **civil engineering, geodesy and transport** - a field of engineering and technical sciences;
    4) **materials engineering** - a field of engineering and technical sciences;
    5) **mechanical engineering** - a field of engineering and technical sciences;
    6) **security studies** - a field of social sciences;
    7) **chemical sciences** - a field of exact and natural sciences.
2. The learning outcomes take into account the requirements specified for the 8th level of the Polish Qualifications Framework.
3. Number of semesters: **8**
4. Number of ECTS credits – min. **30 points**
5. The number of compulsory courses is 100 hours and 20 hours of practical training carried out in the form of conducting classes or participating in them and corresponds to a total of 10 ECTS credits, and the number of optional courses is at least 200 hours and corresponds to at least 20 ECTS credits**.** Optional courses may include classes in optional modules of subjects carried out at MUT for at least 100 hours and 10 ECTS credits, courses taught at another university or scientific institution in Poland or abroad, and other forms of education, e.g. apprenticeships, internships at and outside the MUT in particular at another university or institution in Poland or abroad.
6. Language of conducting:
    a. **Polish or English –** only in the case of subjects, internships or other forms of education indicated in the Individual Education Programme (IPK),
    b. **English –** in the case of education in a scientific discipline in English.
7. The program is valid from **the academic year 2025/2026.**
8. Indication of the relationship between the concept of education and the development strategy and mission of the Military University of Technology:
   Education at the Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is part of the development strategy and mission of the Academy, the essence of which is the professional preparation of future staff in the fields of engineering and technology, exact and natural sciences and social sciences, in particular in the field of military technology and security technology. The task of the Doctoral School is to ensure the transfer of the latest knowledge to doctoral students, the development of skills and improvement of competences at the highest level, as well as the cultivation of patriotic traditions and responsibility for the Homeland in broadly understood aspects, both military and civilian, in accordance with the principle "Omnia Pro

Patria" – "Everything for the Homeland". The activities of the Doctoral School correlate with the strategic objectives of the Academy's development in terms of strengthening the position of the Military University of Technology in the system of Polish and European higher education, including as the leading educational pillar of higher military education and the expert and research base of the Ministry of National Defense, as well as other ministries. In addition, it emphasizes the elite nature of the Academy as a university conducting innovative didactic and scientific activities, also developing international cooperation in this field.

9. Prerequisites for the candidate for the Doctoral School

   The candidate should have a Level 7 qualification. Polish Qualifications Framework (Master's degree, or equivalent) and complete a Master's degree in a field related to the scientific discipline conducted at the Doctoral School or have scientific achievements in this discipline. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may admit a person who is a graduate of first-cycle studies or a student who has completed the third year of uniform master's degree studies. Detailed requirements are set out in the rules of recruitment to the Doctoral School established annually by the Senate of the Military University of Technology.

II. Description of the expected learning outcomes

The description of the expected learning outcomes includes:

- universal first-level characteristics specified in the Annex to the Act of 22 December 2015 on the Integrated Qualifications System;
- second-cycle characteristics set out in the Annex to the Regulation of the Minister of Science and Higher Education of 14 November 2018 on second-cycle learning outcomes for qualifications at levels 6-8 of the Polish Qualifications Framework (PQF).

Explanation of the markings:

1) in the column symbol *and effect number*:
   a) D - doctoral learning outcomes,
   b) W, U, K (after the underline) - category: knowledge, skills, social competences,
   c) 01, 02, 03, ... - number of the learning outcome,
   d) WAT01, ... - number of the learning outcome for subjects for which the university learning outcomes are required;
2) in the description *component code* column - reference of the assumed learning outcome to the appropriate code of the description component of the first- and second-cycle learning outcomes at level 8 of the Polish Qualifications Framework (PQF 8).

The description of the following expected learning outcomes will be achieved as a result of the implementation of the education programme, including the Individual Learning Programme (IPK) and the Individual Research Plan (IPB)

Effect number symbols	Expected learning outcomes	code description component
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting classes.*	*P8S_WG*
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_W P8U_WG*
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*
D_W03	*development trends in the scientific discipline*	*P8S_WG*
D_W04	*research methodology*	*P8S_WG*
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*	*P8S_WG*
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*
Skills: the graduate is able to		
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*	*P8U_U P8S_UW*
D_U02	*create new elements of scientific and creative achievements*	*P8U_U P8S_UW*
D_U03	*independently plan and act for their own development and inspire and organize the development of others,*	*P8U_U P8S_UU*
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks , in particular:* *− define the purpose and object of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions on the basis of scientific research*	*P8S_UW*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*	*P8S_UW*
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*	*P8U_U P8S_UK*
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*
D_U09	*initiate debate*	*P8U_U P8S_UK*
D_U10	*participate in scientific discourse, exchange of experiences and ideas, also in the international environment*	*P8U_U P8S_UK*
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*	*P8S_UK*
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*
D_U13	*plan classes or groups of classes and carry them out using modern methods and tools*	*P8S_UU*

	Social competences: the graduate is ready to	
D_K01	*independent research to increase existing scientific and creative output*	*P8U_K P8U_KK*
D_K02	*taking into account the challenges in the professional and public sphere, taking into account: – their ethical dimension, – responsibility for their consequences and shaping models of appropriate conduct in such situations*	*P8U_K P8U_KK*
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8U_K P8S_KK*
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*	*P8U_U P8S_KK*
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*	*P8U_U P8S_KK*
D_K06	*fulfilling the social obligations of researchers and creators*	*P8U_U P8S_KO*
D_K07	*initiating activities in the public interest*	*P8U_U P8S_KO*
D_K08	*thinking and acting in an entrepreneurial way*	*P8U_U P8S_KO*
D_K09	*maintaining and developing the ethos of research and creative communities, including: − conducting scientific activity in an independent manner, − respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8U_U P8S_KR*

III. Method of verification of the assumed learning outcomes

Verification of the assumed learning outcomes, to the extent resulting from the implementation of the education programme, including an individualised learning programme, is carried out by checking the acquired knowledge, skills and social competences by the doctoral student on the basis of:

- completion of courses included in the Basic Module, including a doctoral seminar in the subject Analysis of the research area,
- credit for courses from the Optional Module of a discipline or scientific disciplines, professional practice and subjects carried out outside the Military University of Technology and other forms of education[1] included in the Individual Education Program (IPK).

IV. Implementation of the education program

1. Education at the Doctoral School lasts 8 semesters.
2. There is one curriculum for all scientific disciplines conducted at the Doctoral School.
3. The curriculum includes at least 300 hours of classes[2] and at least 20 hours of professional internships in the form of conducting classes or participating in them - at least 30 ECTS credits in total.
4. The doctoral student's education program consists of:
   1) the basic module for doctoral students of all scientific disciplines conducted at the Doctoral School, 100 hours with a total of 9 ECTS credits;
   2) optional modules related to the scientific disciplines conducted at the Doctoral School, at least 200 hours each, to which at least 20 ECTS credits have been assigned, subject to sections 6, 7 and 8;

[1] if they appear in IPK

[2] classes may include courses taught outside the Military University of Technology and other forms of education

3) 20 to 180 hours of professional internships in the form of classes or participation in them from the third to the seventh semester of education, – max. 60 hours per year (in accordance with the individual curriculum), which are assigned 1 ECTS credit, regardless of the number of hours of practice.
4) optionally, courses taught outside the Military University of Technology and other forms of education on an hourly basis and the number of ECTS credits specified in an individual curriculum.

5. A doctoral student is required to complete the basic module and 20 hours of professional practice in the form of conducting classes or participating in them. A doctoral student, in consultation with the supervisor from the optional module for the scientific discipline, selects the courses to be carried out so that the total number of ECTS credits corresponds to at least 20 credits. It is allowed for courses to come from different scientific disciplines and to be taught at another university or research institution.
6. In the case of planned completion of courses outside MUT and other forms of education (e.g. internship, internship at and outside MUT), the supervisor determines the number of ECTS credits and the learning outcomes to be achieved, provided that the number of hours of courses taught at MUT from the optional module cannot be less than 100 hours and 10 ECTS credits.
7. In the case of education for foreigners in English, the subjects included in the basic module referred to in Chapter V, concerning the issues of Polish regulations, may be replaced by other subjects. Decisions on the introduction of new subjects are made by the Director of the Doctoral School in consultation with the Chairman of the Scientific Discipline Council, within which the education of foreigners is conducted.
8. The implementation of the education programme, considering the provisions of sections 5-7, should ensure that the candidate achieves the assumed learning outcomes specified in Chapter II.
9. By the end of the first semester of education, the doctoral student submits an individual education program to the director of the Doctoral School, approved by the supervisor or supervisors.
10. Classes in the subjects of the basic module are planned centrally for all doctoral students of the first year, subject to paragraph 11
11. Classes for foreigners providing education in English may be planned centrally or as part of a scientific discipline, considering the subjects referred to in paragraph 7.
12. Classes in the subjects of the optional modules are planned according to individual curricula.
13. Classes in the subjects of the basic module or optional modules can be carried out in a stationary or remote or hybrid form.
14. The decision on the form of conducting classes in the subjects of the basic module is made by the director of the Doctoral School, and in the case of subjects of optional modules, by the lecturer.

V. Modules of the curriculum

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
Basic module, obligatory for doctoral students of all disciplines[3] (I-II sem.)				
1.	Higher education	20	1	*D_WWAT01, D_W05, D_W06, D_UWAT01, D_U03, D_K01, D_K02*
2.	Rules for conducting classes	10	1	*D_WWAT01, D_UWAT01, D_U03, D_U13, D_K01, D_K06*
3.	The process of applying for research funding	10	1	*D_W05, D_U7, D_K01, D_K03, D_K04*
4.	Plan your experiment	14	1	*D_W04, D_U04, D_K04*
5.	Methodology of conducting scientific research	10	1	*D_WAT02, D_U01-U05*
6.	Ownership and commercialisation of research	10	1	*D_W05, D_W06, D_U06*
7.	Scientometrics and bibliometrics in scientific activity	6	1	*D_W05, D_U08, D_K03, D_K04*
8.	Analysis of the research area[4]	20	2	*D_W01, D_W02, D_W03, D_W4, D_U08*
Optional modules related to the scientific discipline of a doctoral student (III-VII sem.)				
1	Automation, electronics, electrical engineering and space technology	min. 200 hrs[5]	min. 20 points	*List of items attachment V.1 - page 11*
2	Informatics and Telecommunications			*List of items attachment V.2 - p. 14*
3	Civil Engineering, Surveying & Transportation			*List of items attachment V.3 - p. 17*
4	Materials Science			*List of items attachment V.4 - p. 19*
5	Mechanical Engineering			*List of items attachment V.5 - p. 22*
6	Chemical Sciences			*List of items attachment V.6 - page 25*
7	Security Sciences			*List of items attachment V.7 - p. 26*
Internship (III-VII sem.) - in accordance with the individual education program				
1	Professional practice in the form of conducting classes or participating in them	20-180 hours	1	*D_WWAT01, D_UWAT01, D_K01*
Subjects taught outside the Military University of Technology and Other forms of education (III-VII sem.) **-** Optionally according to the individual training program				

[3] in the case of education for foreigners in English, the subjects included in the basic module, concerning the issues of Polish regulations, may be replaced by other subjects determined by the Director of the Doctoral School.

[4] course carried out on an individual basis with a supervisor or supervisors or a supervisor and an assistant supervisor completed with a doctoral seminar

[5] the minimum number of hours of classes in the Optional Module may be reduced by the implementation of other forms of education, the sum of ECTS credits for the Optional Module and other forms of education may not be less than 20 points, while maintaining at least 100 hours of classes at MUT in the Optional Module

Lp.	Course/Module Name	number of hours	number of ECTS credits	Reference to learning outcomes/Annex
1	Subjects outside MUT and, for example, internships, internships carried out at and outside MUT at another university or scientific institution in Poland or abroad	*The number of hours, ECTS credits and reference to learning outcomes is determined by the supervisor in an individualised learning programme*		

VI. Framework Program

The framework program includes the characteristics - curricular content of all subjects in the compulsory module and optional modules.

Lp.	Name Item	Curriculum content
Basic module, obligatory for doctoral students of all scientific disciplines		
1.	Higher education	Basic concepts of contemporary general didactics. Functions of academic education, contemporary models of higher education, principles of functioning of higher education. Psychological foundations of the learning process. Principles of curriculum design. Taxonomies of learning objectives. Learning styles vs. teaching styles. Modern methods and techniques of education. Designing didactic classes. Developing the ability to formulate and creatively solve problems; shaping creative attitudes. Evaluation of learning outcomes; assessment methods. Methodology of interpersonal communication; student-teacher relations, moderating the work of student teams; modern methods of supporting students in the learning process. Social competences of an academic teacher. The ethos of a researcher - an academic teacher. History and evolution of the Military University of Technology.
2.	Policy conducting classes	Methodology of conducting classes; basic forms of classes; problem-based education, project education. Principles of planning classes – constructing detailed outlines using modern teaching methods and techniques. Creating teaching materials. Methods of assessing learning outcomes. IT systems supporting the work of an academic teacher. Practical exercises preparing for the implementation of apprenticeships.
3.	Process Inference for financing Research	The process of applying for funding for basic scientific research. Statutory activities, financing of domestic and foreign scientific internships for young scientists starting their scientific careers. General characteristics of the rules for applying for funding in domestic institutions (Ministry of Science and Higher Education, National Centre for Research and Development, NCN, FNP) and foreign institutions (European Union and others).
4.	Plan your experiment	Determined and randomized experiment plans. Measures of position and dispersion of measurement results. Assessment of the significance of the impact of input quantities on the output quantity. Specify a function that approximates the function of an object. Assessment of the adequacy of the function of the facility and the significance of its coefficients. Experiential optimization.
5.	Methodology Conduct research	Analysis of the state of knowledge based on a literature review – creating a synthetic summary of what has been done and what needs to be solved. Creating your own literature databases in accordance with the citation systems used (American and English). Posing a scientific problem that needs to be solved – assumptions (limitations), required theoretical/technological/experimental apparatus, expected time and money outlays, method of verification of the results obtained. Conducting scientific research and its documentation (scientific article as the main element of research documentation). Dissemination of research results: principles of correct oral and poster presentation, conference presentations and scientific publication, principles of citing literature sources, method of self-citation. Rules for determining the contribution to a given study and to whom you should give thanks. Polemics with reviewers – improvement of submitted scientific papers.
6.	Proprietary Rights and commercializatio n Research	Basic information on the methods of intellectual property protection, in particular: copyrights, inventions, utility models, industrial designs, trademarks in the field of intellectual property protection. Issues of commercialization of the results of scientific research and development works.
7.	Scientometrics I Bibliometrics in the activity	Scientometric and bibliometric indicators used in international bibliographic databases (Scopus, WoS), as well as national requirements related to the evaluation of researchers. Dissemination of scientific activities and research results, with particular emphasis on the requirements of the Open Access Policy at MUT regarding the provision of open access

	Scientific	to publications and management of research data. The use of bibliographic databases and e-sources in scientific research. Tools supporting the collection of materials supporting the writing of scientific papers.
8.	Area Analysis Research	Seminar classes supervisor – PhD student. Analysis of the state of knowledge in the field of research issues selected by the doctoral student. Literature review. Definition of the research problem (objective, research questions, subject, hypotheses) and initial definition of the methodology. Preparation of a report and presentation for the first doctoral seminar. Preparation of the draft Individual Research Plan.

Lp.	**Discipline name Scientific**	**Curriculum content**
Optional modules related to the scientific discipline of the doctoral student		
1	Automation, electronics, electrical engineering and space technology	*Annex VI.1 – page 28*
2	Informatics and Telecommunications	*Annex VI.2 – page 35*
3	Civil Engineering, Surveying & Transportation	*Annex VI.3 – page 46*
4	Materials Science	*Annex VI.4 – page 50*
5	Mechanical Engineering	*Annex VI.5 – page 56*
6	Chemical Sciences	*Annex VI.6 – page 65*
7	Security Sciences	*Annex VI.7 – page 69*

VII. Organisation of apprenticeships and other forms of education

Apprenticeships are carried out in the form of teaching classes or participation in conducting them

Detailed rules for the implementation and completion of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology are specified in the following regulations established by the Director of the Doctoral School of the Military University of Technology:

1. *Regulations of professional practice of doctoral students of the Doctoral School of the Military University of Technology".*
2. *"Regulations for the implementation of other forms of education by doctoral students of the Doctoral School of the Military University of Technology."*

VIII. Educational plan

The education plan consists of a general part for all doctoral students of the year and an individual education plan for each doctoral student. The general part of the plan includes a schedule for the implementation of the basic module.

The Individual Education Plan for Doctoral Student Semesters III to VIII is created based on the Individual Education Programme.

PLAN OF EDUCATION AT THE DOCTORAL SCHOOL FROM THE ACADEMIC YEAR 2025/2026
ALL SCIENTIFIC DISCIPLINES CONDUCTED AT THE DOCTORAL SCHOOL

	Modules/Subjects	total hours/ ECTS point		number of hours/ECTS points per semester:													
				I		II		III		IV		V		VI		VII		VIII	
		Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS
Basic module, compulsory for all disciplines																			
	Total	**100**	**9**	**50**	**4**	**50**	**5**												
1	**Didactic of Higher education**	**20**	**1**	**20**	**1**														
2	**Rules for conducting classes**	**10**	**1**	**10**	**1**														
3	**The process of applying for research funding**	**10**	**1**			**10**	**1**												
4	**Design of experiment**	**14**	**1**	**14**	**1**														
5	**Research methodology**	**10**	**1**			**10**	**1**												
6	**Property rights commercialization of scientific research**	**10**	**1**			**10**	**1**												
7	**Scientometrics and bibliometrics in scientific activity**	**6**	**1**	**6**	**1**														
8	**Analysis of the research area**	**20**	**2**			**20**	**2**												
Optional modules related to the scientific discipline - 315 subjects																			
1	**Automation, electronics, electrical engineering and space technologies - 56 subjects**	**min. 200 hours***	**min. 20 pkt ECTS***					**According to the Individual Education Program (IEP)**											
2	**Information and communication technology - 59 subjects**																		
3	**Civil engineering, geodesy and transport - 30 subjects**																		
4	**Materials engineering - 40 subjects**																		
5	**Mechanical engineering - 78 subjects**																		
6	**Security studies - 30 subjects**																		
7	**Chemical sciences - 22 subjects**																		
Apprenticeships																			
1	*Internships in the form of conducting classes or participation in conducting them*	**20-180**	**1**					**According to the Individual Education Program (IEP)**											
Subjects carried out at another university or scientific institution, domestic or foreign - optionally in accordance with the IEP																			
1	*Subjects carried out in direct and remote form*	***according to IEP***						**According to the Individual Education Program (IEP)**											
Other forms of education - optional according to IEP																			
1	*e.g. internships, internships carried out in and outside the Military University of Technology, at another university or domestic or*	***according to IEP***						**According to the Individual Education Program (IEP)**											

** The total number of ECTS credits under the IEP must be min. 21 points, min. the number of hours in the Optional Module may be reduced to 100 hours and 10 points by completing courses outside the Military University of Technology and other forms of education to which the number of hours and ECTS credits has been assigned*

IX. The system of ensuring the quality of education at the Doctoral School

The Education Quality Assurance System at the Doctoral School of the Military University of Technology (QMS SDR WAT) is a set of consciously planned activities providing opinions, analyses and conclusions on the functioning of individual elements of the doctoral education process and indicating the directions of corrective and corrective actions. It is a system subject to constant evaluation and changes, constantly adapted to the needs resulting from internal and external conditions.

The JJK SDR WAT is based on a number of projects and activities aimed at ensuring high quality education and research conducted by doctoral students. Quality assurance is carried out through the implementation of processes in the Education Quality Assurance System at the Military University of Technology and the JCS SDR WAT. The functioning of the system is continuous and systematic, through the continuous involvement of the Academy's organizational units responsible for the process of educating doctoral students, internal and external stakeholders. The activities of the SDR QMS are primarily covered by doctoral students and academic teachers who provide scientific supervision to doctoral students and conduct classes with them.

Supervision over the implementation, functioning and improvement of the SDR QMS is exercised by the Director of the Doctoral School.

Annex V.1
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: automation, electronics, electrical engineering and space technologies

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester academic year
1.	**Computer Network Administration**	**20**	**3**	*D_W03*	*winter*
2.	**Acoustic Electronics**	**30**	**3**	*D_W04, D_W05*	*winter*
3.	**Computer-aided analysis of experimental data**	**30**	**3**	*D_W03, D_U06*	*winter*
4.	**Smart Antennas**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
5.	**Digital Image Processing**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
6.	**Optical Radiation Detectors**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
7.	**Electromechanical energy and signal converters**	**30**	**3**	*D_W01, D_U05*	*winter*
8.	**Laser Physics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
9.	**Physics of laser media**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
10.	**Photovoltaics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
11.	**Supercontinuum Radiation Generation**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
12.	**Imaging Information Engineering**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
13.	**Encoding and recognition of radio transmissions**	**30**	**3**	*D_U05*	*winter*
14.	**Crystallography**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
15.	**Laser absorption spectroscopy in gas sensors**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
16.	**Laser-plasma X-ray and extreme ultraviolet (EUV) sources**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
17.	**Lasers for medical applications**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
18.	**Pico- and femtosecond lasers**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
19.	**Fiber lasers**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
20.	**Mathematical models of the electromagnetic field**	**30**	**2**	*D_W02, D_W03*	*winter*
21.	**Finite Element Method**	**30**	**3**	*D_W02, D_W03*	*spring*
22.	**Methods of analysis and measurement of random signals**	**30**	**3**	*D_W02, D_U05*	*spring*
23.	**Data mining methods and tools**	**30**	**3**	*D_W02, D_W04*	*winter*
24.	**Methods of logical synthesis**	**30**	**3**	*D_W02, D_W03*	*winter*
25.	**Minimizing the electromagnetic susceptibility of infiltration of IT devices**	**30**	**3**	*D_U05*	*winter*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester academic year
26.	**Nonlinear Laser Conversion**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
27.	**Scientific and engineering calculations**	**30**	**3**	*D_W04*	*winter*
28.	**Optoelectronics in safety systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
29.	**Coherent Light Optics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
30.	**Plasma in science and technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
31.	**Remote Sensing Basics**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
32.	**Basics of knowledge about viruses and other pathogens for engineers**	**30**	**3**	*D_W01, D_W02, D_U01, D_U07, D_K01*	*winter*
33.	**Measurements of basic parameters of laser radiation**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
34.	**Designing safety systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
35.	**Programmable and Purpose-Built Circuits**	**30**	**3**	*D_W01, D_U05*	*spring*
36.	**Acoustic sensors**	**20**	**2**	*D_W04, D_W05*	*winter*
37.	**Microwave sensors in radiolocation**	**20**	**2**	*D_W02, D_U04*	*spring*
38.	**Smart radio networks**	**30**	**3**	*D_W01, D_W03*	*winter*
39.	**Optical Spectroscopy for Life Sciences**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
40.	**Digital systems in optoelectronic devices**	**30**	**2**	*D_W01, D_W02, D_W03 D_U07, D_U010, D_K03, D_K05*	*winter*
41.	**Test and measurement systems in the test laboratory**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
42.	**Fiber optic technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
43.	**Terahertz technique**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
44.	**Information concealment technique (steganography)**	**30**	**3**	*D_W01, D_W02, D_U05*	*spring*
45.	**Techniques in Biomedical Engineering**	**30**	**3**	*D_W01, D_W02, D_U01, D_U07, D_K01*	*winter*
46.	**Field theory**	**30**	**3**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
47.	**Thermal imaging and infrared technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
48.	**Optical Radiation Detection Systems**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*winter*
49.	**Laser beams**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*
50.	**Modern transducers measuring physical quantities**	**30**	**3**	*D_W01, D_U05*	*winter*
51.	**Selected issues of the operation of anthropotechnical systems**	**30**	**3**	*D_W08, D_U05 i 06*	*spring*
52.	**Advanced microelectronics technologies**	**30**	**3**	*D_W01, D_U05*	*spring*
53.	**Applications of lasers in technology**	**30**	**2**	*D_W01, D_W02, D_W03 D_U010, D_K03, D_K05*	*spring*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester academic year
54.	**Advanced techniques for digital system design in FPGAs**	**30**	**3**	*D_W02, D_W03, D_U07, D_U09, D_K05*	*spring*
55.	**Selected problems of the statistical theory of radiolocation**	**30**	**3**	*D_W01, D_W02, D_W03 D_U WAT02, D_U05, D_U010, D_K03, D_K05*	*winter*
56.	**Signal processing in radars**	**40**	**3**	*D_W01, D_W02, D_W03 D_U WAT02, D_U05, D_U010, D_K03, D_K05*	*winter*

Annex V.2
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: information and communication technology

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Quantum Algorithms III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
2.	**Algorithm Analysis III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
3.	**Analysis and synthesis of visual information III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
4.	**Next-generation wireless systems (NG)**	**20**	**2**	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*spring*
5.	**ICT Systems Diagnostics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
6.	**Efficiency of ICT systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
7.	**Elements of forecast theory III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
8.	**Software Evaluation III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
9.	**Physical Foundations of Quantum Information III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
10.	**Computer Graphics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
11.	**Software Quality Engineering III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
12.	**Cryptology III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
13.	**Mathematical Methods of Decision Support III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
14.	**Discrete Mathematics III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
15.	**Generative and Aspective Methods in Software Development III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
16.	**Numerical methods III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
17.	**Multi-Criteria Optimization Methods III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01,D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
18.	**Mathematical Modelling III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
19.	**Modeling and verification of ICT networks III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
20.	**Modeling Conflict Situations III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
21.	**Business Process Modeling, Simulation and Analysis III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
22.	**Reliability of Systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
23.	**Optimization III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
24.	**Probabilistic III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
25.	**Stochastic Processes III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
26.	**Image Recognition and Processing III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
27.	**Neural networks and fuzzy logic III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
28.	**Smart radio networks**	**20**	**2**	*D_W01, D_W03,D_U010, D_K03, D_K05*	*winter*
29.	**Stochastic Exploitation Models III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
30.	**Computer Simulation III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
31.	**Database Systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
32.	**ICT systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
33.	**Decision support systems III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
34.	**Artificial Intelligence III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
35.	**Theoretical foundations of computer science III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
36.	**Graph and Network Theory III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
37.	**Project and Process Management III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*winter*
38.	**Complex Data Structures III**	**20**	**2**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05, D_U07,D_K01,D_K03*	*spring*
39.	**5G network application for military**	**30**	**3**	*D_W01,D_W02,D_W03,D_U01D_U02,D_U04,D_U05*	*spring*
40.	**Advanced cryptanalysis tools**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
41.	**Probabilistic graph models: representation**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
42.	**Probabilistic graph models: the basics of inference**	**20**	**2**	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
43.	**Probabilistic Graph Models: Inference Methods**	**20**	**2**	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
44.	**Probabilistic graph models: parameter estimation**	**20**	**2**	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
45.	**Probabilistic graph models and hybrid models**	**20**	**2**	*D_W01,D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01,D_K03*	*winter*
46.	**GNSS – Systems and signals" (GNSS)**	**20**	**2**	*D_W01, D-W02,D_W03, D_U01,D_U02, D_K03, D_K05*	*winter*
47.	**Multidimensional Data Processing (WDP)**	**20**	**2**	*D_W01; D_W02; D_W03; D_U10; DU_04; D_K03; D_K05*	*winter*
48.	**Automated Battlefield Database Systems (SBD-ZPW)**	**20**	**2**	*D_W01; D_W02; D_W03; D_U10; DU_04, D_K03; D_K05*	*Winter*
49.	**Hiding data in telecommunications**	**20**	**2**	*D_W01, D-W02, D_W03, D_U01, D_U02, D_K03, D_K05*	*winter*
50.	**AI in spectral processing and analysis**	**20**	**2**	*D_W01, D-W02, D_W03, D_U01, D_U02, D_K03, D_K05*	*winter*
51.	**Special numbers in cryptology**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*winter*
52.	**Elliptic curves in cryptanalysis of asymmetric ciphers**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*winter*
53.	**Selected elements of the lattice theory**	**30**	**3**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*winter*
54.	**Application of modular lattices in post-kwan cryptography**	**30**	**3**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*winter*
55.	**Fundamentals of Measurement of Disclosing Emissions**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*winter*
56.	**Digital data processing techniques**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*spring*
57.	**Advanced technologies for next generation mobile networks**	**30**	**3**	*D_W01; D_W02; D_W03; D_U10; DU_04, D_K03; D_K05*	*winter*
58.	**Machine learning for telecommunications**	**30**	**3**	*D_W01; D_W02; D_W03; D_U10; DU_04, D_K03; D_K05*	*spring*
59.	**Quantum Communications**	**30**	**3**	*D_W01; D_W02; D_W03; D_U10; DU_04, D_K03; D_K05*	*winter*

Annex V.3
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects
Scientific discipline: civil engineering, geodesy and transport

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Safety and reliability of building structures**	**20**	**3**	*D_W03; D_W05; D_U02; D_K02*	*winter*
2.	**Dynamic interaction of building structures with the soil medium**	**20**	**2**	*D_W02; D_U01; D_K05*	*spring*
3.	**Environmental physics**	**20**	**2**	*D_W03; D_U04; D_K02*	*spring*
4.	**Modeling of thermal and humidity processes**	**20**	**2**	*D_W03; D_U04; D_K03*	*spring*
5.	**Identification of loads and structural systems**	**20**	**2**	*D_W02; D_U02; D_K02*	*winter*
6.	**Investment process in the construction industry**	**20**	**2**	*D_W01; D_U04; D_K05*	*spring*
7.	**Mechanics of road and airport runway soil foundations**	**20**	**3**	*D_W03; D_U02; D_U04; D_K03*	*winter*
8.	**Test Methods for Stiffness and Load-Bearing Capacity of Road and Airport Pavements**	**20**	**2**	*D_W03; D_U07; D_K07*	*lukewarm*
9.	**Design methods for folding bridge structures**	**20**	**2**	*D_W03; D_U01; D_U03; D_K01*	*winter*
10.	**Design methods of the experiment**	**20**	**3**	*D_W02; D_U01; D_K01*	*spring*
11.	**Modeling the Behavior of Reinforced Concrete Elements and Structures**	**20**	**2**	*D_W02; D_U01; D_K01*	*winter*
12.	**Geometric and Physical Nonlinearities in Structural Mechanics**	**20**	**2**	*D_W03; D_U04; D_K05*	*spring*
13.	**Explosive effects on defensive structures**	**20**	**2**	*D_W02; D_U01; D_K05*	*winter*
14.	**Scheduling and costing systems for construction works**	**20**	**2**	*D_W06; D_U06; D_K08*	*spring*
15.	**Engineering of building materials**	**20**	**3**	*D_W04, D_U04, D_K05*	*winter*
16.	**Cartographic methods of research**	**20**	**2**	*D_W02, D_U05, D_U07, D_K03, D_K05*	*spring*
17.	**Spatial data exploration**	**20**	**2**	*D_W02, D_W04, D_UWAT02, D_U01, D_U05, D_K03, D_K05*	*winter*
18.	**Methods and technologies in Geospatial Data Science**	**20**	**2**	*D_W02, D_W03,D_UWAT02, D_U01, D_U05, D_K03, D_K04*	*spring*
19.	**Advanced methods of photogrammetric studies**	**20**	**2**	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
20.	**Programming in spatial information systems**	**20**	**2**	*D_W02, D_W05, D_U06, D_U10, D_K03, D_K06*	*winter*
21.	**Reference systems in geosciences**	**20**	**3**	*D_W02, D_W03, D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*spring*
22.	**Global Geodetic Observing System**	**20**	**3**	*D_W01, D_W03, D_W04, D_UWAT02, D_U05, D_U07, D_K01, D_K03, D_K05*	*spring*
23.	**Modern photogrammetric techniques**	**20**	**2**	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*spring*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
24.	**Selected numerical methods in geodesy**	**20**	**2**	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*winter*
25.	**Methods of parallel data processing**	**20**	**2**	*D_W02, D_W03, D_UWAT02, D_U05, D_K05*	*spring*
26.	**Mathematical foundations of digital image processing**	**20**	**2**	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
27.	**Numerical methods with linear algebra**	**20**	**2**	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*spring*
28.	**Finite element methods in Hermit spaces (polynomials of degree 2 and 3). Nonlinear problems.**	**20**	**2**	D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03	*winter*
29.	**Finite element methods in Hermit spaces (polynomials of degree 2, 3 and 5). Linear problems.**	**20**	**2**	*D_W02, D_W03, D_W05, D_U01, D_U02, D_U04, D_U05, D_U07, D_K01, D_K03*	*spring*
30.	**GNSS Environmental Research Methods**	**20**	**2**	*D_W01, D_W04, D_U WAT02, D_U01, D_U07, D_K03, D_K05*	winter

Optional subjects

Scientific discipline: materials engineering

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Structural studies by X-ray diffraction**	**20**	**2**	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
2.	**Structural studies by scanning microscopy**	**20**	**2**	*D_W01, D_W02, D_W04, D_UWAT02, D_U05, D_U06, D_K03, D_K03*	*winter*
3.	**Mechanical Properties Testing of Engineering Plastics**	**20**	**2**	*D_W02, D_W05, D_U WAT02, D_U04, D_U05, D_U10, D_U03, D_K01, D_K04, D_K09*	*winter*
4.	**Physical Basis of Electro-Optical Effects in Liquid Crystals**	**20**	**2**	*D_W01, D_W02, D_UWAT01, D_UWAT02, D_U06, D_U07, D_U10, D_K04, D_K05*	*winter*
5.	**Calorimetric, thermogravimetric and volumetric methods for testing material properties**	**20**	**2**	*D_W01, D_W04, D_U05, D_K03*	*winter*
6.	**Semiconductor materials for optoelectronic applications**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*spring*
7.	**Nano and ultracrystalline engineering materials**	**20**	**2**	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
8.	**Nanoporous anodic aluminum oxide: synthesis, design and applications**	**20**	**2**	*D_W02, D_W03, D_U WAT02, D_U01, D_U07, D_U03, D_K01, D_K03, D_K05*	*spring*
9.	**Non-telecommunications applications of fiber optics**	**20**	**2**	*D_W01, D_W03, D_W04, D_U01, D_U05, D_U07, D_K01, D_K03, D_K05*	*winter*
10.	**Measurement of machine and device parts using coordinate measuring techniques**	**20**	**2**	*D_W01, D_W04, D_U05, D_U06, D_U07, D_K05, D_K08*	*spring*
11.	**Experiment planning and data analysis using Origin and Statistica**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
12.	**Basic properties of liquid crystals**	**20**	**2**	*D_W01, D_W02, D_W04, D_W05, D_W06, D_UWAT02, D_U01, DU_02, DU_03, DU_05, DU_06, D_K01, D_K04, D_K05, D_K08*	*winter*
13.	**Keysight Vee and Lab View for Data Control and Processing**	**20**	**2**	*D_W02, D_W03, D_W04, D_UWAT02, D_U04, D_K05, D_K08*	*winter*
14.	**Designing technological processes for incremental Direct Deposition methods**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
15.	**Dielectric spectroscopy**	**20**	**2**	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*spring*
16.	**Structural Determinants of Material Properties**	**20**	**2**	*D_W01, D_W03-06, D_UWAT02, D_U01 D_U04, D_U05, D_U07, D_U10, D_U11, D_K03-05, D_K09*	*winter*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
17.	**Modern methods of material characterization**	**20**	**2**	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*winter*
18.	**High-energy ball milling and mechanical synthesis**	**20**	**2**	*D_W01, D_W01, D_U05, D_K03*	*winter*
19.	**Advanced materials for hydrogen storage**	**20**	**2**	*D_W01, D_W03, D_U01, D_K04*	*spring*
20.	**Basics of plasmonics and metamaterials**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*winter*
21.	**Selected Materials and Functional Structures for Photonic Applications**	**20**	**2**	*D_W01, D_W02, D_W03, D_U01, D_U04, D_U07, D_K03, D_K05, D_K05, D_K09*	*spring*
22.	**Computer Image Analysis in Materials Science**	**20**	**2**	*D_UWAT01, D_UWAT02, D_U01, DU_02, DU_03, D_U04, DU_5, D_U07. D_K01, D_K02, D_K03, D_K05, D_K06*	*spring*
23.	**Additive manufacturing of functional materials**	**20**	**2**	*D_W WAT01, D_W02, D_W03, D_W04, D_U WAT01, D_U WAT02, D_U03, D_U05, D_U09, D_K01, D_K05, D_K08*	*winter*
24.	**Methods for amplifying light emission from broadband semiconductor nanostructures**	**20**	**2**	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U07, D_U10, D_K01, D_K03, D_K04, D_K09*	*winter*
25.	**Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals**	**20**	**2**	*D_W01, D_W03, D_UWAT02, D_U04, D_U05, D_U10, D_K03, D_K04, D_K05, D_K09*	*winter*
26.	**Modeling of semiconductor devices.**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U02, D_U03, D_U05, D_K01, D_K03, D_K05*	*winter*
27.	**High-entropy alloys – synthesis, structure, research and properties**	**20**	**2**	*D_W01, D_W01, D_U05, D_K03*	*winter*
28.	**Additive manufacturing of alloys based on intermetallic phases**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
29.	**Combinatorial Materials Manufacturing and Testing Engineering**	**20**	**2**	*D_W01, D_W02, D_W03, D_U WAT02, D_U05, D_U07, D_K01, D_K03, D_K04, D_K05*	*winter*
30.	**Reactive mechanical grinding as a method of synthesis of modern materials for storing hydrogen in the solid phase.**	**20**	**2**	*D_W01, D_W01, D_U05, D_K03*	*winter*
31.	**Additive techniques with elements of reverse engineering**	**20**	**2**	*D_W02, D_W04, D_UWAT02, D_U03, D_U07, D_K03, D_K05*	*winter*
32.	**Overview of additive techniques used in modern technology**	**20**	**2**	*D_W01, D_W03, D_UWAT02, D_D_U10, D_K03*	*winter*
33.	**Selected issues in 3D printing**	**20**	**2**	*D_W01, D_UWAT02, D_U01, D_U08,D_K04, D_K05*	*winter*
34.	**Researcher's workshop 1 – tools for writing scientific texts**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
35.	**Researcher's workshop 2 – writing scientific articles**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
36.	**Researcher's Workshop 3 – Writing Scientific Articles**	**20**	**2**	*D_W04, D_U01, D_U05, D_U12, D_K01, D_K03*	*winter*
37.	**Quantum mechanics in examples**	**20**	**2**	*D_W02, D_W03, D_W04, D_UWAT02, D_U01, D_U05, D_U10, D_U11, D_K01, D_K03, D_K05*	*winter*
38.	**Corrosion testing in materials science**	**20**	**2**	*D_W01, D_W02, D_W03, D_W04, D_U01, D_K05*	*winter*
39.	**Anodic oxides of copper and its alloys – production, characteristics and applications**	**20**	**2**	*D_W01, D_W02, D_W03, D_UWAT02. D_U01, D_U04, D_K03, D_K04, D_K06*	*winter*
40.	**Anodizing of aluminum alloys**	**20**	**2**	*D_W01, D_W02, D_W03, D_UWAT02, D_U01, D_U04, D_K03, D_K04, D_K06*	*winter*

Optional subjects
Scientific discipline: mechanical engineering

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Numerical Analyses in Load-Bearing Structures**	**40**	**4**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
2.	**Autonomy of mobile robots**	**30**	**3**	*D_U04, D_W03, D_K01*	*winter*
3.	**Non-destructive testing of aircraft**	**30**	**3**	*D_W02; D_W05; D_U01; D_K05*	*winter*
4.	**Biomechanics of human body movement during a road accident**	**20**	**2**	*D_W03, D_W05, D_U02 D_U05, D_K04*	*spring*
5.	**Construction and operation of industrial robots**	**30**	**3**	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
6.	**Digital signal processing**	**30**	**3**	*D_W01, D_W02, D_U04 D_U06, D_K01, D_K03*	*winter*
7.	**Dynamics of mechatronic system design**	**30**	**3**	*D_W03,D_W05, D_U02, D_U05, D_K04*	*spring*
8.	**Dynamics of car movement**	**30**	**3**	*D_W03,D_W05, D_U02, D_U05, D_K04*	*spring*
9.	**Dynamics and modeling of hydrostatic systems**	**30**	**3**	*D_U04, D_W04, D_K01*	*winter*
10.	**Dynamics of multi-member systems**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
11.	**Impulse loads of motor vehicles – selected issues**	**20**	**2**	*D_W04, D_U04, D_K09*	*winter*
12.	**Computer-aided operation of machines**	**20**	**2**	*D_W02, D_U05, D_K05*	*spring*
13.	**Shaping a safe car body**	**20**	**2**	*D_W01, D_U04, D_K01, D_K05*	*spring*
14.	**Composite materials in mechanical engineering**	**30**	**3**	*D_W01, D_W01, D_U04, D_K01, D_K05*	*spring*
15.	**Finite Element Method**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
16.	**Methods of analysis of numerical experimental research results**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
17.	**Methods of testing the condition of machines**	**30**	**3**	*D_W03, D_U05, D_K01, D_K03*	*winter*
18.	**Experimental methods for investigating the thermophysical properties of solids**	**30**	**3**	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*spring*
19.	**Methods and techniques for testing the mechanical properties of materials**	**30**	**3**	*D_W03, D_W04, D_U04, D_U05, D_K01, D_K03*	*winter*
20.	**Numerical Methods in Engineering Applications**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
21.	**Numerical Methods in Mechanical Engineering**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
22.	**Methods for designing and optimizing aircraft structures**	**30**	**3**	*D_W01, D_W03, D_U04, D_U05, D_K01, D_K03*	*spring*
23.	**Constitutive Models of Materials in FEM Analysis**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
24.	**Modelling of heat transfer processes**	**30**	**3**	*D_W01, D_W03, D_U01, D_U05, D_K01, D_K03, D_K05*	*winter*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
25.	**Modeling and simulation of mechatronics issues**	**30**	**3**	*D_W04, D_U04, D_K01*	*spring*
26.	**Modeling and simulation of nonlinear mechanical problems**	**40**	**4**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
27.	**Parametric modeling and structural optimization with FEM**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
28.	**Flow modeling**	**30**	**3**	*D_W01, D_W02, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
29.	**Modeling machine motion**	**20**	**2**	*D_U04, D_W04, D_K01*	*spring*
30.	**Modeling composite structures**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
31.	**Modeling of the Contact Phenomenon in Structural Mechanics**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
32.	**Modeling and research of the processes of cooperation between the wheel and the road**	**30**	**3**	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
33.	**Modeling of car traffic and controls**	**30**	**3**	*D_W01, D_W02, D_W03, D_U04, D_U05, D_K01, D_K03, D_K05*	*winter*
34.	**Modern technologies for bonding structural materials**	**30**	**3**	*D_W01, D_W02, D_U05, D_K01, D_K05*	*spring*
35.	**Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems**	**20**	**2**	*D_U04, D_W03, D_K01*	*winter*
36.	**Renewable energy sources**	**30**	**3**	*D_W06, D_U WAT02, D_K07*	*winter*
37.	**CAE Engineering Software**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
38.	**Experiment planning and optimization of mechanical objects**	**30**	**3**	*D_W04, D_U04, D_K05*	*winter*
39.	**Basics of road safety**	**20**	**2**	*D_W03, D_W05, D_U02 D_U05, D_K04*	*winter*
40.	**Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters**	**30**	**3**	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*spring*
41.	**Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters**	**30**	**3**	*D_W04, D_U WAT02, D_U07, D_K02, D_K03*	*winter*
42.	**Fundamentals of Mechanics of Continuous Media**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
43.	**LabVIEW environment in experimental research**	**30**	**3**	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*spring*
44.	**Starting processes of internal combustion engines**	**30**	**3**	*D_W04, D_U04, D_K01*	*spring*
45.	**Programming control systems for unmanned working machines and robots**	**30**	**3**	*D_U04, D_W03, D_K01*	*winter*
46.	**Mechatronic sensors**	**30**	**3**	*D_W03, D_W04, D_U06, D_K01, D_K04*	*winter*
47.	**Condition monitoring systems**	**30**	**3**	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*spring*
48.	**Aircraft Operation Systems**	**30**	**3**	*D_W03; D_U01; D_K03*	*winter*
49.	**Control systems in mechanical engineering**	**30**	**3**	*D_U04, D_W03, D_K01*	*spring*
50.	**Technologies for the production and processing of composite materials**	**30**	**3**	*D_W01, D_W02, D_U04, D_K01, D_K05*	*spring*
51.	**Selected solutions in the field of automotive technology and car motion**	**20**	**2**	*D_W01, D_W03, D_U04 D_K01, D_K05*	*spring*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
52.	**Theory and organization of machine operation**	**30**	**3**	*D_W04, D_U06, D_K03*	*winter*
53.	**Thermomechanics of materials and studies of thermophysical properties**	**30**	**3**	*D_W03, D_W04, D_U01, D_K03*	*winter*
54.	**Tribology**	**30**	**3**	*D_W03, D_U04, D_K05*	*winter*
55.	**Durability of aircraft structures**	**30**	**3**	*D_W02, D_W03, D_U02, D_U05, D_U07, D_K01, D_K03, D_K05*	*spring*
56.	**Introduction to the equations of mathematical physics**	**30**	**3**	*D_W01, D_W02, D_W03, D_U01, D_U04, D_K01, D_K03*	*spring*
57.	**Modern machine and vehicle drive systems**	**30**	**3**	*D_W03, D_U04, D_K05*	*winter*
58.	**Modern test methods for internal combustion engines and vehicles**	**30**	**3**	*D_W04; D_U01; D_U02; D_U03; D_U04; D_U05; D_UWAT01;*	*winter*
59.	**Selected methods and techniques of temperature measurement**	**30**	**3**	*D_W03, D_W04, D_U04, D_K05*	*spring*
60.	**Selected problems of rocket technology**	**30**	**3**	*D_W03, D_U04, D_K05*	*winter*
61.	**Selected issues of waste gas treatment from motor vehicles**	**30**	**3**	*D_W01; D_W02; D_W03; D_K03; D_K05; D_U010;*	*spring*
62.	**Selected issues of simulation of combustion processes and working processes of internal combustion engines.**	**30**	**3**	*D_W01; D_W02; D_W03; D_U05; D_K01; D_K03; D_K05;*	*winter*
63.	**Selected issues of modern programming - introduction to modern programming languages.**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*spring*
64.	**Fatigue strength and fracture mechanics of materials and structures**	**30**	**3**	*D_W01, D_U04, D_K01*	*spring*
65.	**Advanced methods of manufacturing products from sintered powders**	**30**	**3**	*D_W04, D_U04, D_K01*	*spring*
66.	**Advanced ballistics, modeling, and simulation**	**30**	**3**	*D_W01, D_U04, D_K01*	*spring*
67.	**Advanced Mathematics**	**40**	**4**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
68.	**Advanced modeling in structural dynamics**	**30**	**3**	*D_W01, D_W02, D_W03, D_U05, D_K01, D_K03, D_K05*	*winter*
69.	**Advanced measurement systems**	**30**	**3**	*D_W04, D_U04, D_K01*	*winter*
70.	**Advanced Materials Testing Methods**	**30**	**3**	*D_W01, D_W02, D_W04, D_U02, D_U04, D_U05, D_K01, D_K05*	*spring*
71.	**Application of experimental mechanics in scientific research 1**	**30**	**3**	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*winter*
72.	**Application of experimental mechanics in scientific research 2**	**40**	**4**	*D_W01, D_W02, D_W03, D_W04, D_U05, D_K01, D_K03, D_K05*	*spring*
73.	**Application of Finite Element Method in Mechanical Wave Propagation Analysis**	**30**	**3**	*D_W01, D_W02, D_W03 D_U05, D_K01, D_K03, D_K05*	*spring*
74.	**Selected issues of vibration theory**	**20**	**2**	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
75.	**Selected issues in acoustoelectronics**	**30**	**3**	*D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*spring*
76.	**Numerical methods**	**30**	**3**	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
77.	**Electromagnetic field theory**	**30**	**3**	*D_W01, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*
78.	**Quantum mechanics**	**30**	**3**	*D_W01, D_W02, D_W03, D_U04, D_K01, D_K03, D_K05*	*winter*

Annex V.6
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: chemical sciences

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Analysis of Chemical Warfare Agents**	20	2	*D_W03, D_W04, D_UWAT02, D_K02, D_K03*	*winter*
2.	**Chemistry and technology of liquid crystal materials**	20	2	*D_W01, D_W03, D_U06, D_U02, D_K01*	*spring*
3.	**Chemistry and technology of high-energy materials**	20	2	*D_W 01, D_W 03, D_U01, D_U04, D_K01, D_K02*	*spring*
4.	**Polymer chemistry**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
5.	**Chemistry of heterocyclic compounds**	20	2	*D_W01, D_W03, D_W04, D_UWAT02, D_U01, D_U04, D_K01, D_K05*	*spring*
6.	**Chemical Foundations of Environmental Pollution**	20	2	*D_W02, D_W03, D_UWAT02, D_K01, D_K03*	*spring*
7.	**Chiral and polar liquid crystal functional materials**	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*spring*
8.	**Physicochemical Properties of Carbon Materials**	20	2	*D_W01, D_W02, D_W03, DW_04, D_UWAT02, D_U01, D_K03, D_K05*	*spring*
9.	**Physicochemical aspects of the explosion**	20	2	*D_W01, D_W02, D_W03, D_U04, D_U06, D_K01, D_K05*	*spring*
10.	**History of chemistry**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
11.	**Ionization methods in analytics**	20	2	*D_W03, D_W04, D_UWAT02, D_K01*	*winter*
12.	**Methods for preparing samples for analysis**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
13.	**Spectroscopic methods**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
14.	**Modeling and simulation computer programs in chemistry**	40	4	*D_W01, D_W02, D_W03, D_W04, D_U04, D_U05, D_K01, D-K03, D_K04*	*winter*
15.	**Modern nanoporous materials**	20	2	*D_W02, D_W03, D_U WAT02, D_U01, D_K01, D_K03*	*winter*
16.	**Modern methods of synthesis of functional organic compounds**	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*spring*
17.	**Biomedical polymers and biomaterials**	20	2	*D_W02, D_W03, D_UWAT02, D_U09, D_K01*	*winter*
18.	**Practical Tools and Concepts for Modern Organic Synthesis**	20	2	*D_W01, D_W03, D_W04, D_UWAT02, D_U01, D_U04, D_K01, D_K05*	*winter*
19.	**Synthesis of liquid crystals**	20	2	*D_W01, D_W02, D_W03, D_UWAT02, D_U02, D_K01*	*winter*
20.	**Modern analytical chemistry**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*winter*
21.	**Advanced pyrotechnics**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*
22.	**Advanced spectroscopic methods**	20	2	*D_W02, D_W03, D_UWAT02, D_K01*	*spring*

Annex V.7
to the Education Program at the Doctoral School of the Military University of Technology

Optional subjects

Scientific discipline: security studies

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
1.	**Social research in security sciences**	**40**	**4**	*D_W WAT01; D_W01; D_W06; D_UO3; D_K03;*	*winter*
2.	**Statistical methods in social research**	**40**	**4**	*D_WO4; D_U O3; D_U04; D_KO1; D K03;*	*spring*
3.	**Security risk management**	**30**	**3**	*D_WO1; D_W03; D_UO3;*	*spring*
4.	**Security Systems Project Management**	**30**	**3**	*D_W03; D_U04; D_K05;*	*spring*
5.	**Safety Systems Engineering**	**30**	**3**	*D_W03; D_W02; D_UO6; D_U10; D_KO5;*	*winter*
6.	**Safety propaedeutics**	**30**	**3**	*D_W02; D W05; D_U01; D_K05;*	*winter*
7.	**Strategies and concepts of state security management**	**30**	**3**	*D_W02; D_U04; D_KO5;*	*winter*
8.	**Crisis management in public administration**	**30**	**3**	*D_WO1; D_W03; D_UO3; D_U12;*	*spring*
9.	**Universal safety**	**30**	**3**	*D_W02; D_W03; D_U01; D_K07;*	*spring*
10.	**Internal security**	**30**	**3**	*D_W02; D_W03; D_KO5; D_KO7;*	*spring*
11.	**Threat intelligence**	**30**	**3**	*D_W03; D_W06; D_U05; D_U07; D_U10; D_K04; D_K05;*	*spring*
12.	**Survey data analysis**	**20**	**2**	*D_WO4; D_U04; D_KO1;*	*winter*
13.	**Multivariate analyses**	**20**	**2**	*D_WO4; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
14.	**Evaluation research procedures**	**20**	**2**	*D_WO4; D_U04; D_U05; D_KO1; D K03*	*spring*
15.	**Logic and theory of argumentation**	**20**	**2**	*D_WO4; D_U01; D_U04; D_U05; D_KO1; D_K03; D_K04;*	*winter*
16.	**Forecasting and simulations in security**	**20**	**2**	*D_W03; D_W04; D_U WAT01; D_U05; D U13; D_K03; D K04; D K05;*	*spring*
17.	**Modern technologies in security**	**20**	**2**	*D_WO1; D_WO2; D_U; WATO1; D_UO6; D K03;*	*spring*
18.	**Philosophy of security sciences**	**20**	**2**	*D_W02; D_W03; D_U01; D_U05; D_KO1; D_K03;*	*winter*
19.	**Modern terrorism**	**20**	**2**	*D_W03; D_W06; D_U05; D_UO8; D_U09; D_KO1; D_KO6;*	*winter*
20.	**Morale and Security Culture in National and International Relations**	**20**	**2**	*D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*	*spring*
21.	**Safety history**	**20**	**2**	*D_W02; D_W03; D_U; WATO2; D_U05; D_K03; D_KO9;*	*winter*
22.	**Strategic communication**	**20**	**2**	*D_WO1; D_WO3; D_UO6; D_U10; D_KO1; D_KO5*	*spring*

No.	Item Name	number of hours	number of ECTS credits	reference to learning outcomes	Implementation semester per year Academic
23.	**Political security sector**	**20**	**2**	*D_WO2; D_WO3; D_UO8D_U12; D_K02;*	*winter*
24.	**Shaping military security in the 21st century**	**20**	**2**	*D_W04; D_U WAT01; D_U WAT02; D_U05; D_U13; D K03; D_K04; D_K05;*	*winter*
25.	**Information security**	**20**	**2**	*D_W06; D_U01; D_K05;*	*winter*
26.	**The economic dimension of safety**	**20**	**2**	*D_W03; D_U WAT02; D_U05; D_K03; D_K04; D_K05;*	*winter*
27.	**Energy security in the face of socio-economic transformation**	**20**	**2**	*D_W04; D_U WAT01; D_U WAT02; D U05; D_U13; D_K03; D_K04; D_K05;*	*spring*
28.	**Social Determinants of the Security of Modern States**	**20**	**2**	*D_W03; D_W06; D_U04; D_U05; D_KO5; D_K07;*	*winter*
29.	**Environmental security on a global, regional and national scale**	**20**	**2**	*D _W03; D_W04; D_U WAT01; D_U WAT02; D_U05; D 1,113; D_K03; D_K04; D_K05;*	*winter*
30.	**Cultural security factors**	**20**	**2**	*D_W03; D_W06; D_U04; D_U07; D_U10; D_K04; D_K05;*	*spring*

Annex VI.1
to the Education Program (curriculum) at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: automation, electronics, electrical engineering and space technologies

No.	Item Name	Curriculum content
1.	**Computer Network Administration**	Human-machine relations. Socio-technical system. Communication of network devices. Fundamentals of Windows and Linux administration. Configuration of network devices and multimedia services in wired (Ethernet) and radio (5G) networks. Security, reliability and quality of ICT networks.
2.	**Acoustic Electronics**	Technical applications of elastic waves. Elastic waves in solids and their types. Elastic waves in confined media. Ferroelectric materials. Piezoelectricity. Electrostriction. Excitation and detection of acoustic volume waves. Acoustic volume wave filters and resonators. Construction and properties of interdigital transducers. Filters and dispersion lines with acoustic surface wave. Acoustic convolutors and Fourier processors. Acoustoelectronic sensors of mechanical quantities. Acoustoelectronic activators. Remote identification systems. Basics of synthesis of acoustic surface wave systems. Matching acoustoelectronic circuits to external circuits
3.	**Computer-aided analysis of experimental data**	Selected problems in the field of confirmatory and exploratory data analysis including estimation of parameters of various data models, problems of graphical representation of uni- and multivariate data, processing of multivariate experimental results by means of linear transformations, problems of discrimination including methods of minimal-distance classification, nearest proximity, k-means and hierarchical grouping.
4.	**Smart Antennas**	Basic properties of smart antennas. Construction of antenna arrays. Applied solutions for shaping the characteristics of smart antennas. An overview of algorithms used in smart antennas. The principle of operation of adaptive patterns, the properties of their components and the configurations in which they are used in practice. Simulation models of the adaptation process.
5.	**Digital Image Processing**	Digital representation of images. Intensity transformations and spatial filtration. Spatial frequency processing. Image correction. Wavelet analysis. Morphological image processing. Image segmentation.
6.	**Optical Radiation Detectors**	Physical basics of optical radiation detection. Thermal detectors: thermocouples, bolometers, pyroelectric detectors, thermal detector arrays. Photon detectors: photoresistors, p-n, pin, APD photodiodes, with Schottky barrier, UV, VIS, IR detectors, THz detectors, photomultipliers, MCP microchannel plates. CCD and CMOS sensors. Hybrid matrices. Signal reading systems. Architecture of reading chips for CCD and CMOS sensors. Direct detection systems. Noise models of photoreceiver input stages. Detectors from type II superlattices. QWIP detectors. Barrier detectors.
7.	**Electromechanical energy and signal converters**	Electromechanical systems with rotary motion - mathematical description. Generalized theory of electromechanical energy conversion in relation to Euler Lagrange's formalism. State functions, magnetic coenergy function, and generalized external forces. Dissipative elements.
8.	**Laser Physics**	Heisenberg's uncertainty principle, operator operators and equations, Schrodinger's equation. Harmonic oscillator, electromagnetic field quantization. Blackbody radiation. Interaction of radiation with the medium: probabilities of forced transitions, form of spectral line. Laser medium, three-level and four-level and quasi-three-level systems, laser material equations. Gain saturation effect, the condition of stationary laser generation. Laser output power. Laser resonators. Laser beam parameters. Types of non-stationary generation of lasers. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals.
9.	**Physics of laser media**	Interaction of an electromagnetic field with a medium (quantum description). Action of a harmonic perturbation on a quantum object. Electron energy levels of free ions. Therms and multiplets of ions of rare earth elements and transition group metal elements Elements of group theory and their matrix representations. Splitting the energy levels of ions in a crystal field. Electron-phonon interaction. Energy levels of transition group metal ions. Phenomena of energy transfer between ions in active media.

No.	Item Name	Curriculum content
10.	**Photovoltaics**	Quantitative and qualitative characteristics of solar energy. Semiconductor theory in the aspect of photovoltaics. Structures of modern photovoltaic cells. Technology for the production of photovoltaic cells, modules and panels. Photovoltaic modules. Photovoltaic installations.
11.	**Supercontinuum Radiation Generation**	The idea behind the supercontinuum (SC) generation process. Characteristics of tertiary-order nonlinear phenomena (phase self-modulation, cross-phase modulation, self-focusing, four-wave mixing, forced Raman scattering). General characteristics of optical pumps used for SC generation, characteristics of nonlinear media used for SC generation in the visible, near and mid-infrared ranges. Structure and properties of optical fibers with a step change in the refractive index and optical fibers with a photonic crystal structure. Dispersion and methods of shaping dispersion characteristics. Nonlinear Schrodinger equation. Description of the dynamics of SC radiation generation using pulses with duration fs. Description of the dynamics of SC radiation generation using pulses of duration ps, ns and continuous beams. Solitons. Design solutions of supercontinuum radiation sources with high output average power. Applications of supercontinuum sources.
12.	**Imaging Information Engineering**	Machine vision systems, analysis of fast-changing phenomena and processes, interpretation of 2D and 3D scenes, recognition and identification of objects. Fusion of images and data in information systems: analysis and fusion of images in the spectral bands UV, VIS, NIR, IR, THz, analysis of image material based on metadata. Imaging technology in virtual and augmented reality systems: imaging technology in Virtual Reality (synthesis of 3D models, capturing the movement of objects), Mixed Reality – key system components, application solutions.
13.	**Encoding and recognition of radio transmissions**	Error-proofing of data transmission in the SERIAL TONE (MIL-STD-188-110A) system operating in the shortwave range. Error-proof data transmission during automatic ALE (Automatic Link Establishment) connection in a shortwave channel. Analysis of selected radio communication protocols and corresponding algorithms for encoding binary information sequences. Algorithms for generating transmission errors for binary strings corresponding to selected radio communication protocols. Determination of distinctive features enabling automatic recognition of transmission protocols. Algorithm for recognition of selected transmission protocols. Block and convolution code recognition algorithm.
14.	**Crystallography**	Geometric crystallography. Straight and reverse network. Transformations in crystallography. Symmetry in crystallography. Operations and symmetry elements. Matrix representations of symmetry operations. Definition of symmetry group. Characteristics of point and spatial symmetry groups. The symbolism of Hermann-Mauguin and Schoenflies. Classification and characterization of crystal structures. Defects in crystals. Basics of diffractive methods for studying the structure of crystals. Systematic extinctions. Phase problem and ways to solve it. Basic methods of diffractive studies of crystal structure. Studies of defects in the crystal structure and microstructure of polycrystals. Diffraction in the language of Fourier transforms. Tensor description of anisotropic physical properties of crystals.
15.	**Laser absorption spectroscopy in gas sensors**	Gas detection methods and defining gas sensor parameters. Laser absorption spectroscopy. Optical spectra of gas molecules. Basics of optoelectronic gas sensors. Methods to improve the detection limit. Measurements of concentrations in samples of gas mixtures using optoelectronic sensors.
16.	**Laser-plasma radiation sources X-ray and extreme ultraviolet (EUV)**	Methods of producing X-rays and extreme ultraviolet radiation (EUV), basics of laser-generated plasma physics and X-ray and EUV optics, principles of operation and construction of laser-plasma sources of X-ray radiation and extreme ultraviolet radiation (EUV), examples of the use of these sources in science and modern technology.
17.	**Lasers for medical applications**	Description of optical properties occurring in biological media. Physical phenomena and their application in optical therapy and diagnostics. Selected methods of forming radiation distributions in laser systems for medical applications. Laser systems for biostimulation, selected optical diagnostic systems, therapeutic kits – planned effects of laser beam interaction with tissues and selected methods of implementation. Medical applications sources with pico- and femto-second pulse durations. Examples of design solutions for laser sets for medical applications and the therapeutic and diagnostic effects obtained.
18.	**Pico- and femtosecond lasers**	Characteristics of supershort laser pulses and their propagation. Femtosecond optics, dispersion and its compensation. Selected problems of the interaction of supershort pulses with matter. Mode synchronization as a method of generating ps and fs pulses, description in the time and frequency domain. Active and passive mode

No.	Item Name	Curriculum content
		synchronization, realization of passive mode synchronization. Modern solutions of fs lasers. In the direction of atto-seconds.
19.	**Fiber lasers**	Optical fibers, selected geometries, eigenproblem for the fiber, propagation of E-M radiation in optical fibers. Double-walled fibers and photonic fibers. Design solutions for laser pumping systems and fiber amplifiers. Semiconductor pumping lasers used. Fiber laser resonators – structure and properties. Selected methods of shaping the radiation spectrum – doped media. Structure of energy levels of active ions in solid media, levels of ions of rare earth elements, ions of transition group metals - selected issues.
20.	**Mathematical models of the electromagnetic field**	Analytical and numerical methods of calculating the electromagnetic field. Differential relationships. Distribution. Orthogonal functions in wireless communication (LTE and 5G) and radiolocation. Wave propagation in materials and metamaterials. Simplified analytical models for calculating the radiation field. Techniques of calculation using potentials. Radiation field analysis. Field of the elementary Hertz dipole. Morphology of the electromagnetic field. Mathematical and physical conditions of the distant zone criterion. Computational numerical electromagnetism - differential methods.
21.	**Finite Element Method**	Mathematical foundations of FEM. Generation of 2D and 3D meshes. Implementation rules. Libraries supporting FEM programming. Commercial simulation tools.
22.	**Methods of analysis and measurement of random signals**	Generalized structure of random signal analysis procedures. Methods of parametric and non-parametric estimation of signals. Conditions for the implementation of measurements minimizing errors in the estimation of parameters and characteristics. Stationarity, periodicity and normality tests. Assessment of the degree of correlation of signals. Methods of analysis of correlation and mutual spectrum of signals. Estimation of transmittance of the transmission channel.
23.	**Data mining methods and tools**	Basic concepts of "data mining", optimization methods and algorithms used in data mining. Linear and logistic regression methods. Bayes classifiers. Decision trees. MLP and RBF artificial neural networks. Generalization abilities of neural networks. SVM support vector network and its applications in data mining. Classifier and predictor teams. Methods for assessing the quality of classifiers and predictors. Deep neural networks and methods of their learning Transformations and methods of reducing the dimension of data. Selected methods of generation and selection of diagnostic features. Sharp and fuzzy methods of grouping data. Multidimensional data visualization Examples of data mining methods.
24.	**Methods of logical synthesis**	Tasks of logical synthesis. Two- and multi-level synthesis. Algorithms of the ESPRESSO method. Selected procedures of the SIS and Demain programmes. Principles of multi-valued and symbolic minimization. Functional decomposition of combinational systems and its models. Decomposition of sequential circuits: ROM address modification chips and ROM content modification chips. The issues discussed during the lectures will be practiced practically as part of calculation and laboratory exercises, and the main effect of the education will be the acquisition of the ability to consciously use logical synthesis methods in the design of digital devices.
25.	**Minimizing the electromagnetic susceptibility of infiltration of IT devices**	Electromagnetic disturbances as revealing emission. Measurement of the level of electromagnetic disturbance emissions. Uncertainty of measuring the level of electromagnetic disturbance emissions. Assessment of the quality of the results of measurements of the level of emission of disturbances. Protection of IT devices against electromagnetic penetration of information in the form of shielding and filtration. Factors affecting the required shielding efficiency and insertion loss of power supply filters. Methodologies for measuring parameters affecting the level of electromagnetic safety (shielding efficiency, insertion loss of power supply filters and signal filters, absorption and dispersion losses of materials). Examples of applications for the protection of IT devices against electromagnetic penetration of information.
26.	**Nonlinear Laser Conversion**	Elements of crystallography and crystal optics. Properties of uniaxial and biaxial crystals (KDP, LiNbO3, KTP, BBO, LBO, etc.). Electromagnetic wave in a crystal. Frequency mixing in a three-wave approach. Phase matching, scalar and vector synchronizm. Generation II of the harmonic of light and the summation and differential frequencies in uniaxial and biaxial crystals. Parametric light generators and amplifiers, tuning methods. Generation threshold and conversion efficiency. Quasi-phase matching. Nonlinear crystals with a periodic domain structure. Design and application of Optical Parametric Chirped Pulse Amplification circuits

No.	Item Name	Curriculum content
27.	**Scientific and engineering calculations**	Overview of basic numerical methods in the context of implementation. Tools for engineering calculations. Parallel programming. Processing and presentation of calculation results.
28.	**Optoelectronics in safety systems**	Propagation of optical radiation in the atmosphere, reflectance, safety of vision. Laser Rangefinder, Basics of Operation, Flow Chart, Range Equation Improvement of the Noise Signal Ratio, Timing, Probability of Detection, and Probability of False Alarm. Discussion of the principle of operation of lidars: scattering, DIAL, fluorescent, Raman, Doppler. Flame detector, laser scanner.
29.	**Coherent Light Optics**	Preliminaries of stochastic processes. 1st order thermal and laser light statistics. Partially polarized radiation, coherence matrix, degree of polarization. 2nd order statistics, spatiotemporal coherence function. Propagation of the spatiotemporal coherence function, boundary forms of the spatiotemporal function, Van Cittert-Zernike tw. Radial temporal coherence, measurement of the coherence path in the Michelson interferometer, Spatial coherence of radiation, measurement of the coherence radius in the Young interferometer. Measurements of radiation coherence parameters.
30.	**Plasma in science and technology**	Introduction to plasma physics, basic concepts. Movements of charged particles in electric and magnetic fields. Plasma in terms of fluid mechanics. Atomic processes in plasma. Magnetic and inertial maintenance of plasma. Plasma diagnostics. Applications of plasma in technology.
31.	**Remote Sensing Basics**	Interaction of electromagnetic radiation (from microwaves to cosmic rays) and corpuscular radiation and acoustic fields with matter. Physical basis of spectroscopic methods – absorption, scattering, radiation emission. Forms of energy of an atom and a molecule. Nuclear magnetic resonance imaging (NMR) (radiospectroscopy). Electron paramagnetic resonance (EPR) (microwave spectroscopy). Rotational and oscillatory spectra (infrared spectroscopy). Electron spectra (VIS-UV spectroscopy). Active and passive methods of electromagnetic radiation detection as well as image recording and analysis. Spatial, temporal, radiometric and spectral resolution. Multispectral remote sensing. Laser remote sensing systems. Application of laser spectroscopy methods in lidar systems. Spectroscopic methods in the analysis of environmental contamination and pollution. Sensors for security systems and for military applications.
32.	**Basics of knowledge about viruses and other pathogens for engineers**	Presentation of selected issues of microbiology, epidemiology and public health in the light of the latest scientific discoveries. Using the achievements of bioinformatics to describe the world of microorganisms. Discussion of contemporary threats to human and animal health, basic groups of pathogens and ways to prevent infections and infestations. Zoonotic diseases. Gene and genome engineering, biotechnology, threats to ecosystems. The concept of One Health. Basics of immunoprophylaxis and hygiene. Pathogens are particularly dangerous in states of war and natural disasters.
33.	**Measurements of basic parameters of laser radiation**	Measurement methods of radiation spectrum, radiation power and energy, pulse duration and pulse repetition frequency, radiation beam divergence angle. Familiarizing yourself with the basics of laser safety
34.	**Designing safety systems**	Security strategy and principles for creating technical protections. Normative principles and a set of good industry practices. The range of technical protection measures that can be applied. Specificity of protective devices designed for outdoor and indoor applications. A general overview of the solutions used. Characteristics of a set of security devices for indoor and outdoor applications. Working conditions and restrictions on this account. Structure of the technical and detailed design. The scope of the technical executive design in the security industry. Characteristics of the hazard analysis and the concept of the technical design. Rules for detailed design and cost estimation. Design study in the field of technical and detailed design. Required resources to lay the groundwork for the project. Threat analysis. The concept of technical protection of the security system. Rules for conducting a hazard analysis for sample objects. Characteristics of the numerical determination of the scale of the object's hazard. Rules for describing the site area. Attack scenarios and verification of the possibility of technical protection against them. Technical description of the detailed design. Characteristics of the principles of designing alarm systems. Methods of description and graphical representation of the technical design. The way documentation is organized. Examples of technical executive designs of critical infrastructure facilities. Documents related to the technical detailed design. Rules for the development of an investor's and "blind" cost estimate. The need to compile technical catalogues and technical data sheets of devices.

No.	Item Name	Curriculum content
35.	**Programmable and Purpose-Built Circuits**	Technology and methods of designing specialized digital integrated circuits (ASICs) and programmable digital circuits (FPGAs). Principles of digital circuit topography design, power distribution and clock distribution, I/O buffers, IP blocks, and design tools.
36.	**Acoustic sensors**	Features and parameters of modern acoustic sensors. Mechanical structures. Piezoresistive sensors. Magnetoelectric and electromagnetic transducers. Condenser drivers. Acousto-optical transducers. Magnetostrictive transducers. Piezoelectric transducers. Systems with acoustic surface waves.
37.	**Microwave sensors in radiolocation**	Microwave sensors in radiolocation. Broadband microwave sensors with noise signals. Sensors in medical diagnostics. Anti-collision sensors.
38.	**Smart radio networks**	Smart radio network concept. CR architectures. Semantic context of CR. Problems of teaching in the CR system. Dynamic spectrum management. Problems of reception in CR. Ad-hoc CR networks, collaborative MIMO. Standards for CR networks. Security problems in CR. Current research programs in the area of CR.
39.	**Optical Spectroscopy for Life Sciences**	The laws of absorption, dispersion and emission. Excited states of molecules. Orbitals. Photophysical and photochemical phenomena. Jabłoński's diagram Spectroscopic apparatus – light sources, detectors, monochromators, methodologies. Biomaterials and Studied Objects in Biomedical Engineering. Fourier and photoacoustic spectroscopy. Molecular spectroscopy (UV-VIS, fluorescence, Ramana, FTIR). Atomic spectroscopy (ICP, ASA, flame photometry). Spectroscopy in other radiation ranges (NMR, EPR, microwaves, X)
40.	**Digital systems in optoelectronic devices**	Digital system architecture. Digital system design principles. Basic control and digital signal processing. Design of digital modules for signal control and processing. Design of microprocessor systems. Embedded systems design. Exchange of information between digital system modules and with external systems
41.	**Test and measurement systems in the test laboratory**	Signal conditioning systems. Control and measurement systems. Measurement signals and their processing. Measuring instruments and platforms. Interfaces of measuring systems. Automated control and measurement systems in practice.
42.	**Fiber optic technology**	Optical fibres and optics components. Testing of optical fibers and optics components. Lasers and optical transmitters. Photodetectors and optical receivers. Optical signal modulators. Optical signal amplifiers. Digital optical links. Measurements of characteristics and parameters of fiber optic links. Multiplexing and demultiplexing. Coherent transmission. Studies of the characteristics of fiber optic interferometers. Optical analogue links. Radio and fiber optic systems. Optical links in free space.
43.	**Terahertz technique**	Introduction to THz radiation. THz radiation sources – semiconductor and photonic. THz radiation detectors. Photoconductive switches. Time domain spectrometry. Imaging and tomography. Sensors, waveguides, metamaterials THz. Applications THz.
44.	**Information concealment technique (steganography)**	Glossary of data hiding techniques. An overview of practical applications for data hiding in multimedia, speech, radio and network protocols. Differentiation of basic types of algorithms: watermarking and steganography. Classification of data hiding methods. Basic algorithms for embedding and data extraction and their properties. Development of assumptions for the designed system. Selection of the method of embedding and extraction of hidden data. Perceptual models for the Human Auditory and Visual Model. Correction of the additional signal. Methods of evaluating perceptual transparency. Methods of evaluation of resistance and steganoanalytical susceptibility. Examples of software and hardware implementations of data hiding systems. New methods of hiding data – cases and scenarios of action.
45.	**Techniques in Biomedical Engineering**	Fundamental issues and research techniques in biology and biomedicine will be discussed, including the main points of bioengineering and biotechnology. Thus, the skills necessary to undertake interdisciplinary research in these areas of science will be developed. The principles of construction of essential research equipment will be presented, including measurements based on fluorescence excitation. The possibilities of bioinformatics analysis and international databases will be discussed. In addition, the principles of good laboratory practice and safe work in biomedical laboratories will be presented. Requirements for conducting reliable measurements and elaborating results in biomedical research and medical bioengineering will also be discussed.

No.	Item Name	Curriculum content
46.	**Field theory**	Basic concepts and equations of the theory of the electromagnetic field. Maxwell's equations, Properties of mediums and boundary conditions. Fields at the boundary of medium separation, Electromagnetic field energy. Types of electromagnetic phenomena, Electrostatics and magnetostatics. Stationary and quasistationary electromagnetic fields, Maxwell's equations in complex form for harmonic waveforms, Electromagnetic waves. Wave equation for the area without sources, Uniform plane wave. Propagation parameters of a homogeneous plane wave, Propagation of a homogeneous planar wave in a lossless dielectric, Propagation of a homogeneous planar wave in lossy dielectrics, Propagation of a homogeneous planar wave in a good conductor, Structure of a homogeneous planar wave, Reflection and refraction of a homogeneous planar wave at a planar boundary of two different mediums. Reflection and refraction of a homogeneous plane wave at the boundary of two different dielectrics, Reflection of a homogeneous plane wave propagating in a dielectric from the plane surface of a conductive medium Electromagnetic potentials and radiation, Potentials of alternating fields, delayed potentials. Hertz vector potential, Field of elementary oscillator, Electromagnetic field at short distances from the oscillator, Electromagnetic field at long distances from the elementary oscillator, Wave phase, wave type, phase velocity, Propagation of waves in parallel systems of conductors and in waveguides, Transverse electromagnetic wave TEM, Transverse magnetic wave TM in a rectangular waveguide, Transverse electric wave TE in a rectangular waveguide, Base Type, Cuboid Cavity Resonator
47.	**Thermal imaging and infrared technology**	Methods of correction of heterogeneity of matrix detector characteristics in thermal imaging devices. Radiometric calibration of a thermal imaging camera and its impact on the accuracy of remote measurement of temperature and radiation power. Thermal imaging methods for the recognition of chemicals and minerals are based on spectral emissivity analysis. Multi and hyperspectral infrared systems. Active thermal imaging, measurement capabilities and prospects for its application. Infrared imaging polarimetry.
48.	**Optical Radiation Detection Systems**	Signal processing systems for detectors and arrays. Phase-sensitive detection (Lock-In). Detection circuits with synchronous signal integration. Signal averaging detection systems. Coherent detection (heterodyne, homodyne). Advanced methods of optical signal processing in practice.
49.	**Laser beams**	Modeling of laser beams, Measurements of laser beam parameters. Design of optical paths of laser beams. Selected systems and systems of laser beam generation, shaping of laser beam transverse profiles, Folding of laser beams, propagation of laser beams in the atmosphere. Selected applications of laser beams in military science, technology and technology.
50.	**Modern transducers measuring physical quantities**	The concept of a measuring transducer and their classifications. Static and dynamic properties of transducers. Resistance strain gauges. Capacitive, piezoelectric, inductive, magnetoelastic, thermoelectric and pehametric transducers. Conductivity transducers. Flow meters. Fiber optic transducers, their specifics and classifications. Optoelectronic and acoustic transducers. Photoacoustic and photonic transducers. Integrated transducers.
51.	**Selected issues of the operation of anthropotechnical systems**	Interpretation of the concept of operational diagnostics. Methods and ways of diagnosing. A model of the operation process in terms of safety. Uncertainty in the processes of diagnosis and surveillance. Interpretation of the concept of operational reliability. Indicators of operational and maintenance reliability basic reliability structures. Proactively improve reliability. Selected timetables of the facility's runtime.
52.	**Advanced microelectronics technologies**	Modern technologies for the growth of single crystals and the formation of single crystal layers. Technology and the problems of miniaturization. Ultra-fast nanometer electronics. Graphene in modern semiconductor technology. Selected problems of spintronics. Engineering of the energy structure of semiconductors.
53.	**Applications of lasers in technology**	Types of lasers, optical components and systems used in material processing – an overview. Examples of lasers in macro and micro machining. Interaction of radiation with materials, Lorentz-Drude model, optical and thermal parameters of materials, reflection, absorption, energy transport, phase changes, plasma shielding, interaction ranges, thermal conductivity equation. Lasers in surface engineering – polishing, engraving, texturing, hardfacing, impact hardening, cleaning, direct interference lithography in micro- and nanotechnology. Application examples. Lasers in volumetric processing of materials – hardening, welding, cutting, drilling and other applications of lasers in industry. Application examples.

No.	Item Name	Curriculum content
54.	**Advanced techniques for digital system design in FPGAs**	The Advanced FPGA Digital Systems Design Techniques course discusses issues related to, m.in others, the development of integrated digital systems in FPGAs, topographic design, effective use of design constraint attributes, preparation of functional tests, and good design practices. The course is divided into a theoretical part (lectures) and a practical part (laboratories and a project), and the results of the project work carried out are discussed at the seminar. Before taking the course, it is advisable to know the Hardware Description Languages (HDL) and the architecture of FPGAs.
55.	**Selected problems of the statistical theory of radiolocation**	Signal detection and mathematical statistics, optimization criteria (Bayes criterion, Neyman-Pearson criterion, criterion for maximizing SNR values, min-max criterion). Signal detection rule, relationship of the likelihood ratio (decision statistics) for basic signal models with the receiver structure. Bayesian synthesis of TES systems. Bayesian estimation of signal parameters – radar echoes. Relation of the radar uncertainty function (Woodward function) with the problems of synthesis of complex signals. Distinguishability and accuracy of measurements in time and frequency. Cognitive radar vs "silent" radar.
56.	**Signal processing in radars**	Presentation of basic and advanced techniques of radar signal processing. Types of probing signals. Filtration matched. Doppler filtration. Eliminate interference. Radar echo detection.

Annex VI.2
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: information and communication technology

No.	Item Name	Curriculum content
1.	**Quantum Algorithms III**	Mathematical foundations of quantum computing: operators in Hilbert spaces, tensor product of Hilbert space and vectors in this space, Hermitian and unitary operators. Description of a quantum system and its states. Description and properties of measurement in quantum systems. Forms of recording information. Information processing. Quantum gates. A generic form of a quantum algorithm. Deutsch-Jozs problem, Grover's algorithm, Shor's algorithm. Quantum optimization algorithms. Quality of quantum computing.
2.	**Algorithm Analysis III**	Algorithms and algorithmic problems. Introductory concepts. Definition of an algorithm, criteria for the quality of algorithms, complexity of the algorithm and complexity of the task, numerical stability of algorithms, principles of designing effective algorithms. Computational complexity of combinatorial algorithms. Types of tasks, sequential models of computation (DTM and NDTM), problem transformations, computational complexity classes, NP-completeness, temporal and memory complexity of algorithms (pessimistic and expected), sensitivity of algorithms (pessimistic and expected), examples of complexity estimation. Approximate algorithms Methods for estimating the accuracy of algorithms. Polynomial approximation schemes (PTAS), fully polynomial approximation schemes (FPTAS), examples of approximation algorithms for computationally difficult problems. Heuristic search methods. Techniques for designing effective algorithms Recursion vs. iteration, divide-and-conquer techniques, parallelization techniques, advanced data structures and algorithm complexity. Advanced models and methods of graph and network theory. Examples of the use of methods for designing effective algorithms.
3.	**Analysis and synthesis of visual information III**	Weierstrass theorem and orthogonal spanning of signal state space. Basics of the theory of function approximation. Transforms with orthogonal span with unlimited carrier. Laplace's and Fourier's Transform. Orthogonal bases with limited carrier. Wigner, Wannier, and wavelet functions. Wavelet transform – definitions and examples. Applications of the wavelet transform. Process singularities as extreme and/or singularity points of the signal. Searching for extreme and singular points of the signal in wavelet spaces.
4.	**Next-generation wireless systems (NG)**	Development trends. Networking. Radio interface techniques. Development of services and applications. Organization and management in NG systems. Applications of artificial intelligence (AI) and machine learning (ML). Bulk systems, D2D (Device-to-Device) systems, transport systems. Cognitive NG networks. Green communication.
5.	**ICT Systems Diagnostics III**	General theory of functional testing. Types and properties of tests. Error and control effectiveness of the test. Methods of determining tests. The use of tests in recognition (of the condition of the object), in technical diagnostics and in data processing. Test Methods for Digital Devices and Logic Networks. Ways of propagation of unfitness. Conditions for the transfer of the consequences of unsuitability. Masking unsuitability. Roth's algebra. Random testing methods for digital devices. Methods for compressing test results. Compression spectrum. Signature analysis and its application. Diagnostic procedures. Thorough diagnosis. Methods of determining optimal procedures. Models and methods of system diagnostics. Self-diagnosing systems. Diagnosing the system by means of diagnostic dialogue between its elements. Structures of diagnostic dialogue and their properties. Diagnosing the system by means of diagnostic opinions on its elements. Structures of diagnostic opinions and their properties. Determination of diagnostic structures with specific properties. Software Diagnostics. Properties of the program control transfer network.
6.	**Efficiency of ICT systems III**	ICT network efficiency indicators. Stochastic models of event streams. Models of local and wide area computer networks. Wireless and cellular network models. Stochastic and deterministic problems of task scheduling.
7.	**Elements of forecast theory III**	Basic concepts of forecast theory. Linear and nonlinear trend models. Naïve models, moving average and exponential smoothing models. Forecasting based on econometric models. Forecasting qualitative phenomena.

No.	Item Name	Curriculum content
8.	**Software Evaluation III**	The essence of software evaluation. The concept of software quality. Factors shaping the quality of software: quality of the project, quality of implementation. Software quality assessment criteria: computational complexity, reliability. Methods for assessing the computational complexity of algorithms. Computational complexity of algorithms: time complexity, memory complexity. Methods for assessing the time complexity of algorithms. Asymptotic complexity of recursive iterative algorithms. Methods for assessing software reliability. Software reliability models: time domain models, data domain models, phenomenological models. Methods of practical use of software reliability models. Software quality assurance methods. Reviews and inspections. Principles of conducting inspections and reviews in the software development process. Testing. Types and methods of software testing. Design test datasets. Criteria for completing the testing process. Formal methods of constructing and verifying the correctness of programs. Hoare's logic. Inference rules. A description of the program through states and operations. The concept of implicit specification of operations. Proving the correctness of operations. Proving the correctness of programs. The role and importance of standards in the process of ensuring the required quality of software. Characteristics of standards in the field of software engineering. Software quality standards. Use of standards.
9.	**Physical Foundations of Quantum Information III**	Introduction to quantum mechanics. Introduction to quantum electrodynamics. Hilbert space and L2 space. Q-bit and its physical implementations. Mathematical representations of q-bit. The uncertainty principle and its consequences. Mixed states and convoluted states. The Stern-Gerlach experience. Schrodinger's cat and the superposition of states, Bell's inequality. Superposition and entanglement of states. Open layout and closed layout. The holism of EPR states. Space Seal. Fermions and bosons and entanglement. Physical realizations of entangled states in optics – examples. Teleportation of states.
10.	**Computer Graphics III**	Introduction to computer graphics, basic applications - computer animation, visual simulation, AR and VR systems. Vector graphics, raster graphics - representation of image data. Basic graphics standards - GKS, PHIGS, OpenGL. Raster algorithms - Bresenham, anti-aliasing, HLHSR. Geometric modeling - curves and surfaces, 3D objects. Geometric transformations - translations, rotations, scaling, projection. Color modeling - color perception, CIE, RGB, HLS, HSV(B) color models, color space transformations. Lighting modeling - lighting models, shading algorithms, raytracing, radiosity. Texture Modeling - Defining, mapping, and filtering textures.
11.	**Software Quality Engineering III**	Reliability as a measure of software quality. Software quality metrics. The concept and indicators of software reliability. Organizational and software methods of shaping the reliability of software in the process of its development. Software reliability models. Classification and general characteristics of software reliability models. Time-domain models: reliability rates, finite error models, infinite error models. Models with the data domain: reliability indicators, the concept of the operational profile of the program, the Nelson model. Phenomenological models: complexity measures based on the number of lines of source code, Halstead measures, McCabe cyclomatic measures, object-oriented measures. Model evaluation criteria. Methods for determining the parameter values of software reliability models. Maximum probability method. The method of least squares. Examples of estimation of parameter values of selected software reliability models. Modeling the reliability of the program in the testing process. A mathematical model of the program testing process. Program testing strategy. Program reliability indicators. The cost of the testing process. Use optimization methods to determine the program testing strategy. Methods of computer-aided assessment of software reliability. Assessment of the possibility of computer-aided software reliability assessment. SMERFS software package^3. CASRE software package. Software quality engineering. Quality management system. ISO 9001:2000 standard. CMMI Maturity Model. Use of standards related to software reliability assessment: IEEE/ANSI Std 982.1- 1988, IEEE/ANSI Std 982.2-1988.
12.	**Cryptology III**	Basic concepts and history of cryptology. Modular arithmetic. Classic cryptosystems. Cryptanalysis of ciphers. Stream ciphers. Block ciphers. AES and NESSIE competition. Asymmetric cryptosystems. Hash functions. Cipher security. Cryptographic protocols. Applications of cryptography
13.	**Mathematical Methods of Decision Support III**	Decision-making process and cycle. Mathematical modeling of decision-making processes. Optimal and approximate decisions. Modeling the preferences of the Decider. Sensitivity analysis of optimal solutions. Usability features. Decision-

No.	Item Name	Curriculum content
		making under uncertainty. Methods of determining the representation of sets of irreparable decisions. Methods for determining "approximate sets of optimal solutions". Examples of modeling decision support processes.
14.	**Discrete Mathematics III**	Relationships and functions. A relationship of equivalence, order, good order. The principle of abstraction. Maximum, minimum, largest, smallest, majoranta, minoranta. Surjections, injections and beatings. Permutations. Generalized operations on sets. Recursions. Counting sets and functions. Counting techniques. Binomial and multinomial coefficients. Stirling numbers. Surjection, injection and bijection counting. Bell numbers. Euler numbers. Catalan's numbers. Break down the number into its components. Asymptotics. Creating functions. Asymptotic notations. Universal recursion. Asymptotic approximations. Operations on creating functions. Generating functions for selected strings. Determining the number of solutions to Diophantine equations. Recursion Solution. Sets with repetitions. Divisibility of integers. Modulo operation. Division algorithm. Euclid's algorithm. The basic theorem of arithmetic. Congruences. Fermat's small theorem. Solving congruences and congruence systems. Chinese residual theorem. Euler's Functions and Theorem. Elements of graph theory. Graph counting. Coloring vertices and graph branches. Associations in graphs. Transversals and matroids. Capacitive networks.
15.	**Generative and aspective methods in manufacturing software III**	Advanced modeling in UML: diagrams of classes, use cases, sequences, states, activities. UML methodology: application field and consistency rules. Metaprogramming and metamodeling. Generative techniques: Generation of state and test machines. Contract specification on the example of OCL. Elements of AspectJ-oriented programming: junction points, intersection points, Councils, AOP applications
16.	**Numerical methods III**	Basic concepts of numerical analysis: vectors, matrices and norms; rounding errors in computer calculations; conditioning of the calculation task; numerically correct and numerically stable algorithms. Solving linear systems of algebraic equations: conditioning the problem; Gaussian method with full and partial selection of the main element; the Cholesky-Banachiewicz method; the Householder method; the impact of rounding errors on the result; poorly conditioned tasks. Linear least squares problem: distribution of matrices by special values; a generalized inverse matrix and a generalized solution of a system of linear equations; algorithm with a normal equation; algorithm with Householder transformation; the conditioning of the task; regularization. Finding the roots of nonlinear equations: the secant method and its properties; tangent method, sphere and convergence exponent; fishing method.
17.	**Multi-Criteria Optimization Methods III**	Mathematical basis of optimization. Formulation of a multi-criteria optimization task. Dominant and non-dominated solutions. Pareto optimization. Ideal and anti-ideal point. A compromise solution. Methods of objectivizing rankings. Hierarchical optimization. Optimization for multiple goals. Examples of formulating multi-criteria optimization tasks.
18.	**Mathematical Modelling III**	Principles of mathematical modeling. Mathematical model. Data, decision variables and indicators. Analysis of the information level. Correct data. Acceptable decisions. Possible KPI values. Goal Achievement Evaluation Features. Optimization task. The task of extremization. Multi-criteria and game models. Criterion space. A relationship of domination in the Pareto sense. Lexicographic order. The method of compromise. Ideal point and nadir point method. Satisfactory solutions. Methods of analyzing game situations. Extensive form of the game. Normal character of the game. Dominated strategies. Iterated elimination of pure strategies. The best answer. The point of equilibrium in the sense of Nash. Backward induction method. Coalition games. Multiple games. Probabilistic models Risk-based decision-making. Replacing a random variable with its characteristics: expected value, quantile, probability of favorable and unfavorable events, variance. The principle of not taking small probabilities into account. Application of multi-criteria methods. Dominance of the efficiency of the indicator. Decision trees. Lotteries. Usability feature. Fuzzy models Fuzzy sets. Optimal decisions in fuzzy conditions. The goal, limitations and decision are blurred. Operations on fuzzy sets. Cartesian product. Fuzzy numbers. Relationships blurred. Elements of fuzzy logic. Fuzzy: negation, conjunction, alternative, implication, and equivalence. Models with uncertainty Maximin , maximax, Hurwitz, Laplace, Savage criteria. Confidence indicator. Uncertain variables. Decision making with uncertain data. A relationship of indistinguishability. Lower and upper approximation of the set. Approximation

No.	Item Name	Curriculum content
		accuracy. Optimal decisions with approximate data knowledge. Decision boards. Deterministic and non-deterministic rules. Uncertain variables.
19.	**Modeling and verification of ICT networks III**	Basics of verification of ICT systems (ST) based on formal models: model verification, models of parallel systems, linear-time properties, safety and service life. Elements of Petri Net Theory (SP): model properties, problems of marking reachability and network lifetime, constructing an achievability tree and a state diagram. Basic types of Petri nets: time, stochastic, coloured (CPN). Time-based ST modeling: analysis of simple and interval time SP, analysis of temporal stochastic networks. Elements of the theory of time automata. ST modeling with time automatons. Examples of tasks of modeling and verification of ICT systems: testing the properties of the system based on the model using the following tools: PIPE-2, CPN Tools, UPPAAL.
20.	**Modeling Conflict Situations III**	Modeling conflict situations. Quality criteria in conflict situations. Game models. Strategy games. Balance points. Balance in Nash's sense. Cooperative games. Modeling group decision-making processes. Optimization task with multiple goals. Trade-offs in game models.
21.	**Business Process Modeling, Simulation and Analysis III**	Modeling of functions and business processes. Principles of designing the processes of the organization's functioning. Models and methods of business process design. Function hierarchy diagrams. Business process diagrams. Service process diagrams. WorkFlow systems. BPMN notation. BPMN Notation Properties. Objects in BPMN notation. Events, simple and complex activities, logic gates, and control flows in BPMN notation. Describe roles in BPMN notation. Process patterns in BPMN notation. WorkFlow systems modeling and analysis environments. Review of WorkFlow modeling and analysis environments compatible with BPMN notation. ARIS environment from Software AG. WebSphere Business Modeler Advanced from IBM. Sybase's Power Designer environment with Simul 8. Testing the effectiveness of WorkFlow systems. Methods of examining the properties of WorkFlow systems composed of business process diagrams. Time and cost characteristics of business processes. WorkFlow system performance indicators. Use of WorkFlow class system modeling and analysis environments.
22.	**Reliability of Systems III**	Basic concepts of reliability theory. The generalized state of the object. Assessment of the condition of the facility. Structural function. Reliability states. Reliability of the technical facility. Reliability model. Reliability indicators. Classification of objects from the point of view of reliability tests. Reliability of non-renewable facilities Reliability model of a non-renewable facility. Definitions of reliability indicators of a non-renewable facility. Basic properties of reliability indicators of a non-renewable facility. Methods for determining the values of reliability indicators for non-renewable facilities. Selected timetables. Reliability of renewable facilities with zero renewal. Reliability model of a renewable facility with zero renewal. Definitions of reliability indicators for renewable facilities with zero renewal. Basic properties of reliability indicators of renewable facilities with zero renewal. Methods for determining the values of reliability indicators for renewable facilities with zero renewal. Reliability of renewable facilities with non-zero renewal. Reliability model of a renewable facility with non-zero renewal. Definitions of renewable facility reliability indicators with non-zero renewal. Basic properties of the reliability indicators of a renewable facility with non-zero renewal. Methods for determining the values of reliability indicators for renewable facilities with non-zero renewal. Reliability of systems. System reliability model. Reliability structure. Structural reliability function of the system. Examples of reliability structures. Probabilistic reliability model of the system. The process of changing the reliability states of the system. Redundancy in the system.
23.	**Optimization III**	Overall optimization task. Classification of optimization tasks. Convex tasks. Methods of solving linear problems. Discrete tasks. Relaxation, restrictions. Algorithms for solving PCL, PCLM, PLB problems. Evolutionary algorithms for discrete optimization. Nonlinear tasks without limitations. Methods for solving nonlinear problems with constraints. Parallel computations in optimization. Probabilistic algorithms. Evaluation of the quality of optimization algorithms.
24.	**Probabilistic III**	Multivariate random variables. Parameters of multivariate random variables. Examples of univariate and multivariate distributions. Random Variable Functions. Application of characteristic and creative functions. Limit theorems. Asymptotic properties of distributions. Parametric and non-parametric estimation. Parametric tests. Nonparametric tests. Randomness study. Analysis of partial and multiple correlations. Multivariate regression analysis.

No.	Item Name	Curriculum content
25.	**Stochastic Processes III**	Random sequences and their properties. A probabilistic description of the stochastic process. Process examples. Markov trials. Ergodicity. Counting processes. Queuing systems and characteristics. The Semi-Markov Trials.
26.	**Image Recognition and Processing III**	Introduction to the issues of digital recognition and image processing. Frequency methods in digital image processing. Image acquisition, spatial methods in image processing. Improving image quality with filtering. Frequency methods in digital image processing, basics of the use of transforms in digital image processing and analysis. Introduction to image recognition methods. Segmentation algorithms using the following methods: thresholding, edge separation, area growth, divisions and merges, point classification. Application of the Hough transform for analytical curves and irregular objects. Application of neural networks, including deep learning methods, for image recognition (models, applications).
27.	**Neural networks and fuzzy logic III**	Multi-layered neural networks and algorithms for their training. Neural network as an approximator of functions. Fuzzy sets and approximate inference. Fuzzy-neural control and approximation. Fuzzy controls with rule learning. Fuzzy Logic Toolbox in Matlab.
28.	**Smart radio networks**	Smart radio network concept. CRAHN ad-hoc networks. CR hardware and software architectures. Semantic context of CR. Problems of teaching in the CR system. Policies in the CR network. Dynamic spectrum management. Sensing and spectrum sharing. Collaboration and competition in CR networks. Security problems in CR. Standards for CR networks and CR solutions in NG (New Generations) networks
29.	**Stochastic Exploitation Models III**	Introduction to stochastic modeling of systems. Complex technical systems. Operating conditions. Modelling objectives. Uniformity and stationarity of the functioning and operation of technical systems. Efficiency of technical systems. Models of Markowa operation of technical systems. The use of DD class Markow models for modeling the functioning and operation of systems. The use of DC-class Markov models for modeling the operation and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a Markov model. Semi-Marko models of the operation of technical systems. Application of Semi-Marko models to model the functioning and operation of systems. Instantaneous and borderline probabilities of the system staying in states. Limiting probabilities of the system residing in subsets of states. Estimating dwell times in subsets of states. Presentation of the functioning of a selected computer system in the form of a semi-Markovsky model. Queuing models of technical system operation. Simple queuing systems. Open systems. Closed systems. Markowo queuing systems. Niemarkowo queuing systems. Queue networks. Modeling systems using queuing systems. Queuing models of basic computer system structures. Computer network models. An example of the operation of a technical system. Presentation from assumptions to the implementation of a stochastic model of the functioning or operation of a computer system. The impact of the development of design assumptions on the form of the stochastic model of operation and operation. Study of the properties of a computer system based on the study of its stochastic model.
30.	**Computer Simulation III**	Models and methods of formal description of complex processes subject to experimental study. Determination of the simulation model, advantages and disadvantages of simulation methods, types of research problems. Basic laws and theorems used in computer simulation. Methods of generating numbers and random processes, testing random generators. Continuous and discrete simulation systems, the issue of time lapse in computer simulation, basic principles of designing simulation experiments, statistical analysis of simulation results. Methods for testing the adequacy of simulation models. Parallel and distributed simulation, general characteristics of simulation languages. Presentation of simulation systems and environments. Computer simulation trends.
31.	**Database Systems III**	Basic concepts, database systems and information systems. Data models: hierarchical, network, relational, object-oriented. Database system architecture, data description levels, the essence of central data management and independence, defining and processing languages, database management system tools. Data modeling and normalization, practical data modeling. Security and data protection in classic and statistical databases. Methodological basics of database design. Application of databases: databases vs. application systems, commercial

No.	Item Name	Curriculum content
		database systems, warehouses and data mining. Formulation and discussion of selected research tasks in the field of databases.
32.	**ICT systems III**	Route and link availability control in the LAN environment: LAN availability control using the STP protocol, HSRP protocol and default gateway availability control, link load control using access control lists. High-performance routing protocols for LANs: VLSM technique, route aggregation using VLSM, default routes – broadcast, classless routing problems, characteristics of link state routing protocols, characteristics of EIGRP and OSPF protocols. NAT and PAT address translation. DHCP protocol: the principle of operation of the address translator, forms of NAT and PAT implementation. Technologies and protocols in WANs: characteristics of selected protocols used in WANs, packet switching networks and channel switching. Basic concepts related to QoS systems: architecture of quality assurance systems, DiffServ model, IntServ model. Packet classification: IP Precedence and DSCP – structure and interpretation of IP header field values, marking and classifying packets by switching devices in layers 2 and 3 of the reference model. Methods of managing bandwidth, congestion and queuing of packets: characteristics of queuing methods – FIFO, WFQ, PQ, CQ, LLQ, congestion avoidance using the RED and WRED gate algorithm. MPLS protocol – integrating MPLS with the QoS system: characteristics of the MPLS protocol, principles of operation of border and internal routers of the MPLS domain, traffic management and congestion avoidance in MPLS VPNs, configuration of switching devices using labels. Private VPN networks: the concept of VPN, methods and protocols for VPN implementation, examples of VPN implementation using GRE tunneling and IPSec protocol, MPLS-based VPNs.
33.	**Decision support systems III**	Methods of identifying decision-making processes in management and management systems. Basic concepts of decision analysis. Models of decision-making processes in a selected class of systems, formulation of decision-making tasks based on adopted models using optimization methods and artificial intelligence. Predictive models. Introduction to the design of decision support systems. Principles of designing a decision support system for a specific management or management system, development of a language system, knowledge system and task processing system, formulation of project tasks for SWD. The use of IT tools to construct algorithms and decision support systems for specified decision-making tasks. Principles of using simulation games in the process of evaluation and decision support. Methods of verification of decision support algorithms. Presentations of decision support environments and tools.
34.	**Artificial Intelligence III**	Paradigms of artificial intelligence and areas of its applications, limitations of artificial intelligence – Gödel's theorem and Church-Turing's thesis. Formal systems – alphabet, formulas, axioms and rules. Propositional and predicate calculus. Herbrand and Skolem's theorem, Introduction to Artificial Intelligence Languages. Space search techniques (classical, evolutionary, taboo search, simulated annealing). Machine learning, approximate sets, elements of neural networks. Knowledge bases and knowledge representation – ontologies and semantic networks. Inference methods (classical, fuzzy). Algorithms for recognizing patterns in data mining.
35.	**Theoretical foundations of computer science III**	Algorithmic theory of information. Accuracy and correctness of algorithms. Computation models, deterministic and non-deterministic Turing machines, probabilistic machines, non-uniform computations. Turing-sense complexity of algorithms. Types of complexity. Decision and optimization problems. Polynomial transformations of problems. The complexity of the problems. Classification of problems: classes P, NP, NP -complete and strongly NP -complete, Co-NP, PSPACE. Complexity hierarchies. Models for defining and recognizing character patterns. Language, grammar, languages designated by grammars. Deterministic and non-deterministic finite automata. Finite languages accepted by automata. Regular expressions. Regular expression generated languages. Context-free grammars. Normal forms grammar. Contextual grammars. The generational power of grammars, regular expressions, and finite automata. Parallel computing models.
36.	**Graph and Network Theory III**	Graph definition. Graph as a model of the system. Characteristics of the graph and elements of its structure, measures of vertex centrality. Types of graphs. Graph parts, subgraphs, and partial graphs. A complex graph as a special type of graph. Graph coloring. Stable subsets of graph vertices. Graph databases. Graph chromatics. Graph coloring models. Algorithms accurate and approximate graph coloring, on-line graph coloring. Computational complexity of coloring algorithms.

No.	Item Name	Curriculum content
		Routes, chains and roads in graphs. Definitions of route, chain, road. Graph consistency and strong consistency. Cyclomatics and graph carcasses. Computational complexity of the algorithms discussed. Berge Graphs. Definition and types of Berge graphs. Components of strong digraph cohesion. Leifman algorithm. Roads in digraphs. Layered representation of the digraph. Euler's and Hamilton's paths in the graph. Computational complexity of the algorithms discussed. Graph similarity. Measures of exact graph similarity: graph isomorphism, graph homomorphism, largest common subgraph, smallest common overgraph. Measures of approximate similarity of graphs: editing distance of graphs, iterative measures. Methods of pattern recognition using measures of graph similarity. Network. Network definition. Economic carcasses. Extreme roads in cyclic and acyclic networks in the sense of roads. Network methods of analysis of complex projects (CPM, PERT, GERT). Stochastic networks and the fundamental problems defined in them. Computational complexity of the algorithms discussed. Flows in networks. Flow on a standard network. Separating cross-section and its throughput. Algorithm for determining the maximum flow. Edge and vertex consistency. Roads are disjoint apical and edge-wide. Menger's theorem. A satisfying flow with a minimum cost. Computational complexity of the algorithms discussed. Optimal Quotas Specify the allocation as a bipartite network association. Hall theorem. Algorithm for determining the most abundant quota, the most numerous allocation with the minimum cost. Computational complexity of the algorithms discussed.
37.	**Project and Process Management III**	Functional and process concepts of management: definitions and classes of operating systems, place and classes of processes, identification of system features, organizational structures, the essence of process management, management strategies. The essence and role of projects in organization management: definitions and classes of projects, management functions and project management cycle, systemic aspects of the subject of design, formal project structures, basic design cycle, identification of project needs, areas of project management, complexity of processes and projects. Identification of the life cycle of projects and products: product life cycle and project life cycle, needs analysis and definition of requirements, definition of project assumptions and constraints, artifact models according to systems engineering, construction and prototyping, verification, documentation and closure of the project, implementation and implementation, improvement, annihilation of the project, process and product. Planning of project processes: planning the scope and effects of the project, analysis and planning of project and process costs, evaluation of projects and processes, analysis of the value of projects and processes, planning the usability and functionality of project processes, planning the reliability of project activities, planning of control and verification of results, project risk management. Quantitative and qualitative analysis of design processes: analysis and evaluation of the effectiveness of project processes, defining project quality, measures and methods of estimating project quality, quality management of processes and projects, project logistics management. Time-cost validation of design processes: project process budgeting, activity-task structures of processes, project time evaluation, project scheduling, project improvement and development processes, change management, project integration management. Innovation process management: the concept of innovation, classification of innovation processes, organization of requirements and planning of innovative processes, evaluation of innovation processes and systems, product design, design of technological processes, principles and methods of innovation management. Organization of the design entity: the place of the entity in the organizational structure of the company, organization and planning of the structure of project teams, hierarchical and flat organizations, network and virtual models, hybrid models, tasks and selection of project teams, institutional forms of project management, control and evaluation of project teams, communication management in the project, methods and techniques of process improvement, models of management development Process. Project and process management using benchmarking: methods, techniques and tools of design support, CAD/CAISE computer aided design systems, management of the design process through the project repository, X-engineering strategy in design processes based on utility models, functionality of packages supporting the management of design processes, spatio-temporal and cost conditions. Development tendencies in project management: the essence of the rhomboid

No.	Item Name	Curriculum content
		model of project management, principles and foundations of good projects, innovation, technology, complexity and pace of project implementation, implementation of the rhomboid model in project organizations, conditions for the implementation of process models in project organizations, implementation costs and limitations.
38.	**Complex Data Structures III**	List structures. One-way and two-way lists. Implementation of lists. Basic operations. Applications of letter structures. Binary trees. BST trees: properties, implementation, basic operations, and their time complexity. Methods for balancing BST trees. An overview of the applications of BST trees. AVL trees: properties, implementation, basic operations, uses. Red and black trees: properties, implementation, basic operations, uses. RST trees: properties, implementation, basic operations, uses. Trees partially ordered. Properties of partially ordered trees. Binary mounds: properties, types, basic operations. An overview of the uses of semi-ordered trees. Jointable mounds. Binomial trees and mounds: properties, basic operations, applications. Fibonacci mounds: properties, structure, basic operations, applications. Multidirectional trees. B-trees: properties, implementation, basic operations, and their time complexity. Types of B-trees. Applications. Data structures for disjoint sets. Representation of disjoint sets. Basic operations on disjoint sets. Applications.
39.	**5G network application for military**	5G network technologies. 5G use cases and system concept. 5G Network Architecture. 5G architecture elements and functionalities/roles. Millimeter wave communications. Device-to-device (D2D) communications. The 5G radio-access technologies. Machine-type communications. Massive multiple-input multiple-output (MIMO) systems. 5G Network Miltary Gaps. Sensors and effectors. Military scenarios (use cases). 5G network Military Application and use cases: 5G network in Spectrum Situation Awareness application (workshop). 5G network Military Application and use cases: (own work/seminar/workshop with teacher support).
40.	**Advanced cryptanalysis tools**	Elliptic curves, hyperelliptic curves and the concept of a diviser. Attacks on elliptic curves using transfer methods. Improper and degenerate curve attacks: An example of a practical attack on TLS-ECDH. Index method on elliptic curves over extended and straight bodies. Quantum attacks: Shor's and Grover's algorithm. Algebraic attacks. Transformation of factorization, discrete logarithm, and algebraic attacks into the QUBO problem. Application of quantum annealing in cryptanalysis. Isogeny-based cryptography. Practical attacks on the post-quantum scheme of SIDH. Cryptanalysis of selected cryptological problems.
41.	**Probabilistic graph models: representation**	Basics – probabilistics, graphs, information theory, optimization; Bayesian lattices and directed graphs; Markow's networks and undirected graphs; local probabilistic models.
42.	**Probabilistic graph models: the basics of inference**	Strict inference, elimination of variables; approximate inference: approximation with probability propagation, progressive sampling, Markov chains and Monte Carlo methods; inference algorithms, inference in state space models.
43.	**Probabilistic Graph Models: Inference Methods**	Information entropy; Transmitting confidence-rated messages; inference: variational, using Monte Carlo methods, using Markov chains.
44.	**Probabilistic graph models: parameter estimation**	Machine learning of graphical models; linear models; estimation of model parameters; models with incomplete data; Teach undirected models predictive models; Deep neural networks, Bayesian neural networks.
45.	**Probabilistic graph models and hybrid models**	Causality, complex decision-making model; models with hidden variables; statespace models; deep machine learning with graph models; decisions under uncertainty – selected algorithms for approximate inference and learning.
46.	**GNSS – Systems and signals" (GNSS)**	The state of the art of GNSS - the introduction to GNSS, the classification of systems, and areas of implementation of GNSS. The architecture of systems and elements – structures, description & characterization of physical processes, technical parameters, and areas of application. Signals in GNSS – classification, mathematical models of signals, propagation of signals, interferences of signals, methods of protection of signals. Modeling and simulation of systems and signals. Modeling and simulation of jamming and spoofing.
47.	**Multidimensional Data Processing (WDP)**	Basics of the theory of pattern recognition in data. Pattern definition, pattern classes, and the process of recognizing patterns in data. Pattern recognition techniques used. Division of data classification and grouping methods. Grouping

No.	Item Name	Curriculum content
		criteria and methods. Threshold criteria (nearest and most distant neighbor). The distance of Euclid, Sebestyen, Mahalanobis, Hamming, Cannber and selected similarity functions. Grouping methods based on hierarchical grouping algorithms. Construction of dendrograms. Extraction of distinctive features using polynomial interpolation (Lagrange analysis).
48.	**Automated Battlefield Database Systems (SBD-ZPW)**	Basic terminology and characteristics of databases. Requirements for databases. Database technology, data models, data structures, data model operators, integrity constraints. Developer tools. Database management system (software, functionality). Database System Architecture (ANSI/SPARC). Database system users. Implementation technologies. Communication architecture. Division of database systems. Entity relationship model, relationship modeling, entity hierarchy. Transformation, entity transformation rules, relationship transformation rules. Standardization and its process and basic concepts. The first (1NF), second (2NF), third (3NF) and fourth (4NF) normal form. Concurrent data access, data loss after failure. ACID transaction properties, transaction state diagram, logical vs. physical transaction, transaction model and classification, transaction executions. Operational data structures in the MIP model JC3IEDM database. Replication, transformation and data exchange based on the DEM protocol. Databases in battlefield analytics
49.	**Hiding data in telecommunications**	Data formation in the process of mapping and shaping, modern methods of marking and steganography, detection of hidden information channels, paradigms of data hiding, study of selected cases, perception and steganoanalysis of hidden communication channels. Development of marking methods for telecommunications systems and their qualitative analysis.
50.	**AI in spectral processing and analysis**	Analysis of signals in the radio spectrum. Basic characteristics and imagery for the spatial domain and the transform domain. Detection and extraction of events on the radio scene. Forming, detecting and classifying radio signals using Deep Learning methods. Short- and long-term prediction using LSTM networks. Identification of the friend-alien in the radio spectrum.
51.	**Special numbers in cryptology**	The aim of the lecture is to familiarize the audience with numbers (mainly natural numbers) of particular importance in cryptology. Examples of numbers used in cryptography are RSA numbers and their extensions. On the other hand, in cryptanalysis, smooth and partially smooth numbers, but also generic and balanced natural numbers play a special role. Their meanings are revealed, for example, when studying the distribution of divisors of prime typical natural numbers, as well as their numbers - described by the classical "omega" functions. Applications will include the complexity of algorithms used in the cryptanalysis of asymmetric ciphers.
52.	**Elliptic curves in cryptanalysis of asymmetric ciphers**	The aim of the lecture will be to study asymmetric ciphers, selected attacks on such cryptosystems and computational problems related to their security. The main emphasis will be on the importance of special numbers in cryptanalysis of ciphers using the difficulty of the problem of factorization of natural numbers and the problem of discrete logarithm, with particular emphasis on the problems of DLPC, ECDLP, CDH, DDH and their applications in cryptosystems with bilinear operation. Reductions between special computational problems will be shown, including the reduction of the natural number factorization problem for the calculation of Fourier coefficients of the L-Hecke function.
53.	**Selected elements of the lattice theory**	The aim of the lecture is to familiarize the student with advanced concepts in the field of number geometry and lattice theory, which are used in modern asymmetric cryptography. We will analyze in detail the problems computationally on the grids, their difficulty, complexity and appropriate reductions. We will discuss the meaning of dual lattices, their properties and the relationships between the grating and dual lattice. We will explain in detail the concept of smoothing factor and its impact on the quality of lattice solutions in the context of cryptographic security.
54.	**Application of modular lattices in post-kwan cryptography**	As part of the lecture, we will discuss the origin and construction of selected cryptographic schemes based on MLWE, MLWR modular problems. We will analyze in detail the special importance of modular lattices for postquantum cryptography and discuss the reasons for the advantage of modular lattices and

No.	Item Name	Curriculum content
		MLWE/MLWR over RLWE. We will analyze the schemes (KEM, DSS) from the CRYSTALS family and the Smaug, Haetae schemes, we will perform a comparative analysis in order to indicate the global tendencies of their construction from the perspective of achieving safety. We will discuss ROM and QROM along with the differences, and conduct formal proofs of safety of IND-CCA2 AND UF-CPA, for KEM and DSS, respectively.
55.	**Fundamentals of Measurement of Disclosing Emissions**	Revealing emission – myths and reality (not every emission is a revealing emission). Sources of disclosing emissions and methods of reception. Electromagnetic compatibility issues, equivalent diagrams of emission sources. Issues of conducted emission measurement, construction of emission measurement stations for 230V power supply and low voltage power supply (maximum 5V). Measuring stations for emission measurement at communication and management interfaces.
56.	**Digital data processing techniques**	Functions and functional spaces; Banach and Hilbert spaces. Interpolation and mid-squared approximation with polynomials. Interpolation, Mean Square Approximation, and Plywood Smoothing. Smoothing discrete data. Numerical integration, simple and complex interpolation quadratures. Numerical differentiation.
57.	**Advanced technologies for next generation mobile networks**	The aim of the course is to deepen knowledge of mechanisms and algorithms implemented in the latest generation of cellular networks (5G and 6G) used for network management and traffic management based on the division of traffic (slicing). Since the fifth generation of mobile networks, traffic management has been based on Slices and Network Function Virtualization. Lectures provide knowledge about operating mechanisms and knowledge about research on new management mechanisms. The projects convey the ability to propose other mechanisms and algorithms along with their implementation in mobile networks.
58.	**Machine learning for telecommunications**	The first part of the course will reveal statistical data learning theories, which are a toolkit for understanding data. These tools essentially cover two classes: supervised learning and unsupervised learning. Basically, supervised learning refers to the prediction of outcomes based on one or more inputs. One or more estimators make such a forecast. The estimator(s) choice is closely related to the nature of the data. On the other hand, unsupervised learning provides a relationship or pattern in data with no supervised outcome. The second part of the theory described in the course presents the AI decision-making theory. This theory discusses how to represent knowledge, including incomplete and uncertain knowledge about the data (measurements, estimations, etc.); how to use these models and inference methods to decide what to do, especially by making plans (Constraint Satisfaction Problems, CSP); and how to reason and make decisions (Multi-criteria decision making) in the face of uncertainty about the world. The final part deals with Machine Learning, which describes both symbolic and statistical learning methods and reinforcement learning, deep learning, and multi-agent learning (game theory) to generate the knowledge required by the reasoning and/or decision components of intelligent agents or systems. Here, the methods and algorithms for providing machine learning will be analysed, and the theory of artificial intelligence will be revealed and analysed.
59.	**Quantum Communications**	The main objective of the course is to explore the fundamentals of quantum communications technology. The first part ofthe course introduces basic concepts of quantum electrodynamics like field quantisation, coherent states, entanglement, anihilation and creation operators. Based on this knowledge main quantum key exchange algorithms are consistently introduced, i.e. BB84 and E91. In the second part, the basics of bit error analysis, quantum information theory and vulnerabilities of quantum key distribution algorithms are discussed. In the last part, selected implementation aspects of quantum key distribution in modern telecom networks are explored.

Annex VI.3
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: civil engineering, geodesy and transport

No.	Item Name	Curriculum content
1.	**Safety and reliability of building structures**	Knowledge in the field of safety and reliability of building structures. Classifications and rules for shaping the load-bearing structures of buildings and the conditions for assessing their safety. Methods of description and distribution of random variables. Functions of reliability and damage intensity. Methodology for conducting reliability tests, risk assessment, the safety of building maintenance and their effectiveness.
2.	**Dynamic interaction of building structures with the soil medium**	Methods of formulating computational models of the dynamics of structural elements and systems as well as the soil foundation medium of the building. Determination of the physical characteristics of the soil medium under static and dynamic loads. Influence of the content of the phases on the parameters of the substrate.
3.	**Environmental physics**	The laws of the black body. The atmosphere as an ideal gas. Thermodynamic processes in the Earth's atmosphere. The greenhouse effect and ozone holes. Greenhouse gases – a reminder. Natural disasters (earthquakes, volcanic eruptions, tsunamis). Pollution of the atmosphere, hydrosphere and lithosphere, Noise and civilization diseases. Renewable energy sources – Polish's attitude to the protocols of the Climate Summits. Types of light sources for lighting. Indoor and outdoor illumination, luminous flux, illuminance, luminous efficacy, light source spectrum, standard observer, objective determination of the source color.
4.	**Modeling of thermal and humidity processes**	Modeling of thermal and humidity processes. Energy balances of heat demand and air conditioning of the building. Conduction of heat and moisture through the layered partitions of the building – walls, ceilings and floors on the ground, in the conditions of various centres adjacent to the partitions. Conduction equations and methods of solving them. Application of the method of initial functions in the interpretation of heat and moisture fluxes in the modeling of thermal and humidity processes in building elements. Solutions to the Laplace equation using field theory concepts. (gradient, divergence, rotation). Description of solutions to the Laplace-Poisson equation by the method of separating variables. Major potentials in the theory of moisture diffusion and heat conduction in a porous medium. Equations for moisture diffusion and heat conduction in a porous medium. Determination of potential and flux functions in fluid and in porous medium Flux and potential functions, Problems of their determination.
5.	**Identification of loads and structural systems**	Identification of load intensity, weight and stiffness. Gravitational and dynamic loading of structural systems together with the analysis of their reasonable static schematization or determination of the dynamic model. The basis for identification are the results of the initiating reactions of the supporting systems of objects, which are revealed by static or dynamic displacements or vibration frequencies.
6.	**Investment process in the construction industry**	Organization of construction investments, in particular methods of analysis, research and design of construction, assembly, reconstruction, renovation and operation of buildings in a specific place, time, system environment and natural environment. Principles of testing the effectiveness, technology and organization of construction works, preparation and implementation of construction projects, structure and operation process of construction facilities.
7.	**Mechanics of road and airport runway soil foundations**	Modeling of the soil as a single-phase or three-phase continuum depending on the type of soil (cohesive or no-cohesive). Stiffness and load carrying capacity of the ground as the problem of an elastic half-space. Dynamic effects generated by moving loads.
8.	**Test Methods for Stiffness and Load-Bearing Capacity of Road and Airport Pavements**	Testing the stiffness and load-bearing capacity of road and airport surfaces allows to verify the performance and approval for safe use, The testing techniques are based on the use of the wave theory of elastic half-space, which is equipped with layers of the substructure and the surface itself. Half-space reaction is forced by means of impacts with a dynamic plate and registration of surface deflections under moving loads. Factors influencing the results of the research - soil, material and climatic parameters.
9.	**Design methods for folding bridge structures**	Construction of folding bridges with determination of their technical and operational parameters. Theory of Calculation of Folding Bridges Taking into Account Mounting Clearances for Objects in Static and Dynamic Systems.

No.	Item Name	Curriculum content
10.	**Design methods of the experiment**	The essence of experimental research. Resistance extensometry. Measurements and analysis of measurement errors. Organization of the measurement line. Experimental methods of testing materials in simple stress conditions - tensile, compression, shear, bend, torsion tests. Materials testing in complex stress states. Assessment of rheological properties of materials - creep and relaxation. Optical research methods in mechanics – elastooptics, optical, mesh and holographic interferometry.
11.	**Modeling the behavior of elements and structures reinforced concrete**	Reinforced concrete structures as material compositions of concrete and reinforcing materials. Modeling of static and dynamic behavior of structural materials: concrete and reinforcing steel. Modeling the cooperation of component structural materials in elements. Reinforced concrete homogenization method: models of a substitute, homogeneous structural material taking into account the properties of the components of structural materials. Modeling of the mechanisms of destruction of reinforced concrete elements and structures: cracking and crushing of concrete. Application of FEM in modeling the behavior of reinforced concrete structures.
12.	**Geometric and physical nonlinearities in mechanics Design**	Deformations of flaccid structures and bodies with low rigidity, the use of geometric relationships with linear and nonlinear terms. Consequences of deformation in equilibrium equations written in the deformed configuration. The full spectrum of nonlinearities of the physical compounds of the material is considered along with the associative and non-associated laws of strain.
13.	**Explosive effects on defensive structures**	Physics of phenomena generated by explosion of explosive charges and fuel-air mixtures. Methods of determining the parameters of explosion loads. Types of mechanisms destroying elements and load-bearing structures of buildings.
14.	**Scheduling and costing systems for construction works**	Principles of scheduling and cost estimation with the use of currently available specialized IT techniques and software. The idea of BIM technology and its possibilities at all stages of the construction project and the operation of the facility. Optimization formulas and methods of solving multi-criteria decision-making problems in construction.
15.	**Engineering of building materials**	Contemporary trends in the modification of building, construction and finishing materials. Technologies of preparation, implementation and optimal procedures for incorporating materials and products under building conditions. Structure and material considerations of composites used in construction. The role of additives and admixtures in buildings technologies.
16.	**Cartographic methods of research**	The use of maps to describe, analyze and scientifically learn phenomena, including cartometric research, mathematical and statistical analysis and methods of mathematical theory of information. Issues related to, among others, distribution analyses (potential maps, concentration analyses), dynamics of phenomena, as well as correlation methods and trend methods.
17.	**Spatial data exploration**	Review of exploratory data analysis methods with particular emphasis on geospatial data, including classification and grouping, reduction of the number of variables, and spatial pattern discovery. Classification using decision trees and the Byesian classifier, hierarchical grouping, and quality evaluation of classifiers and model validation.
18.	**Methods and technologies in Geospatial Data Science**	Advanced geospatial data processing, analysis, and modeling. Searching for trends and dependencies using exploratory data analysis techniques, machine learning and artificial intelligence, m.in.: real estate market, land cover changes, population distribution. The quality of the data and its impact on the effect of forecasting and modeling, as well as effective reporting and visualization of results.
19.	**Advanced methods of implementation of studies photogrammetric**	Problems of filtering radar images. Use wavelet analysis in image filtration. Morphological operations on digital images. Determination of MTF. Fundamental problems of contemporary digital photogrammetry. Digital image acquisition systems – photogrammetric digital cameras and VHRS and Nano satellite systems. Remote sensing and photogrammetric methods of data acquisition. Modern photogrammetric technologies – their applications in the development of site and elevation maps, digital terrain model and orthophotomaps, as well as 3D spatial maps. Application of Computational Intelligence Algorithms in contemporary photogrammetric studies. Characteristics of new multi-image fitting methods. Methodology for developing dense point clouds from images.
20.	**Programming in spatial information systems**	The use of the programming environment, the concept of procedure, function and instructions for data processing. A way of accessing and processing spatial data directly using programming code. Libraries that enable spatial data processing in the .NET environment, the ability to automate the ArcGIS environment using Python.

No.	Item Name	Curriculum content
21.	**Reference systems in geosciences**	We live on a dynamic planet in constant motion that requires long-term continuous quantification of its changes in a truly stable frame of reference. To be understood in context, when the motion of the Earth's crust is observed, it must be referenced. The global geodetic frame of reference is the fundamental basis for measuring worldwide processes and is crucial for its proper interpretation especially for climatic studies. A terrestrial reference frame provides a set of coordinates of some points located on the Earth's surface. It can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space. This rotation is assessed with respect to a frame tied to stellar objects, called a celestial reference frame. The Earth Orientation Parameters (EOPs) connect these two frames together. Nowadays, four main geodetic techniques are used to compute accurate coordinates: the GPS (Global Positioning System), VLBI (Very Long Baseline Interferometry), SLR (Satellite Laser Ranging), and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite). They all use networks of stations located on sites covering the whole Earth. Modern realizations are of kinematic type, which means that they include station positions and velocities. They model secular Earth's crust changes that is why they can be used to compare observations from different epochs. The Ph.D. students will learn about advancements of the International Terrestrial Reference System (ITRS) which is a World spatial reference system co-rotating with the Earth in its diurnal motion in space for the geodetic, but also astronomical, and geophysical communities.
22.	**Global Geodetic Observing System**	Global Geodetic Observing System (GGOS) is the Observing System of the International Association of Geodesy (IAG). GGOS and its related research and services address the relevant science issues related to geodesy, geodynamics and geophysics in the 21st century, but also issues relevant to society, like global risk management, geo-hazards, natural resources, climate change, severe storm forecasting, sea level estimations and ocean forecasting, or the space weather. The Global Geodetic Observing System works with the IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research. GGOS mission is to: (i) provide the observations needed to monitor, map, and understand changes in the Earth's shape, rotation, and mass distribution, (ii) provide the global geodetic frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications, and (iii) benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built. Within this subject Ph.D. students will advance their understanding of the dynamic Earth system by quantifying our planet's changes in space and time and learn about the integration within the geodetic, geodynamic and geophysical communities at the highest level, in service to the technical community and society as a whole.
23.	**Modern photogrammetric techniques**	A modern approach to photogrammetric studies based on the use of the latest techniques of processing imagery obtained from various altitudes and the use of their geometric relationships in the field of situational and elevation measurement in areas including: development and updating of maps, feeding topographic databases, supporting the construction of 3D cadastre, as well as cooperation with mobile systems in the field of building virtual reality at various levels of detail.
24.	**Selected numerical methods in geodesy**	Practical use of numerical methods to solve scientific and technical problems (geodesy), ideas and concepts of numerical methods, numerical algorithms, programming elements - computational scripts. Use of selected tool libraries of scripting languages such as Matlab, Octave and Scilab.
25.	**Methods of parallel data processing**	Methods of parallel data processing for solving scientific and technical problems in geodesy. Ideas and concepts of parallel data processing methods. Selected parallel processing algorithms. Examples of programs that parallelize numerical calculations. Parallel processing methods of scripting languages: Octave, Scilab. Methods and functions of the Parallel Computing and MATLAB Distributed Computing Server Toolbox modules.

No.	Item Name	Curriculum content
26.	**Mathematical foundations of digital image processing**	Creating gradient and edge filter masks based on differential diagrams constructed using the finite difference method (FDM) and the finite element method (FEM) (convergence, agreement, order of precision, π- as the first form of differential approximation). Spectral properties of masks (matrices of the third and fifth order), including the spectral transfer function and its graphical presentation. The goodness of the mask is defined as the quotient of the spectral transfer function of the filter under study and the spectral transfer function of the differential transfer of the Laplace operator. Operations on masks (addition, subtraction, 45° rotation), determining the form of the differential operator related to the results of these transformations (Laplacian, bi-Laplacian, etc.). Filters that identify only corners (vertices). Bi-Laplacian mask vs. Harris corner detector.
27.	**Numerical methods with linear algebra**	Vector norm, matrix norm, induced norm. Norm 1, 2 and maximum. Matrix conditioning indicator. The use of linear algebra methods in numerical (differential) solving of mathematical physics problems (advection equation, diffusion, diffusion problem with advection). Convergence and stability of the differential method. Spectral transfer operator. π- a form of the first differential approximation. Numerical diffusion, creation. Analysis of selected differential schemes in terms of spectral properties – explicit, implicit, semi-implicit scheme, Crakn-Nicholson, Crank-Nicholson-Galerkin. Dissipation and dispersion in Lax-Wendroff and Beam-Warming schemes used in civil engineering and trance-sport.
28.	**Finite element methods in Hermit spaces (polynomials of degree 2 and 3). Nonlinear problems.**	The scope of the course in the winter semester includes the presentation of the form of differential schemes for the problems of nonlinear advection, nonlinear diffusion and the BKdV equation – soliton in shallow and deep water. Fortran program + presentation and discussion of results.
29.	**Finite element methods in Hermit spaces (polynomials of degree 2, 3 and 5). Linear problems.**	The finite element method has been known for many years (at the Military University of Technology it was created and developed by Prof. Szmelter, Dacko, Dobrociński, Wieczorek, Niezgoda, and now Winnicki). It is an engineering method (light, heavy, aircraft, medical - stents) and a method of solving equations and systems of equations (linear and nonlinear) of partial differentials. These issues have been dealt with for years by the team of the Department of Military Hydrometeorology. The scope of the course in the summer semester includes the presentation of the forms of polynomials of degree 2-5 forming the basis of functions approximating the solution of the differential problem with the initial condition and examples of forms of differential schemes for the problem of linear advection and linear diffusion. Fortran program + presentation of results.
30.	**GNSS Environmental Research Methods**	Issues related to the use of satellite navigation systems in geodynamic, tectonic and atmospheric monitoring. The basics of GNSS systems, such as GPS, GLONASS, Galileo or BeiDou, as well as various types of GNSS receivers and their application in the scientific and technical environment. GNSS data processing and interpretation of results in environmental studies. Application of GNSS data in modeling of atmospheric processes. Analysis of ionospheric parameters based on GNSS signals. Determination of tropospheric water vapour (PWV) content from GNSS data. Monitoring of tectonic plate movements. Analysis of crustal deformations: landslides, subsidence, vertical and horizontal movements.

Annex VI.4
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: materials engineering

No.	Item Name	Curriculum content
1.	**Structural studies by X-ray diffraction**	Basic concepts and laws of crystallography. Translation, spatial lattice vs. crystalline lattice. Crystal lattice theory, Interplanar distances. Reverse network. Stereographic projection. Wulf grid. Classification of crystalline bodies. Types of structures. X-ray diffraction on a crystal lattice. Design, principle of operation and analytical capabilities of the X-ray diffractometer. X-ray qualitative and quantitative analysis. Stress and texture measurements.
2.	**Structural studies by scanning microscopy**	Terms used in electron microscopy. Principles of operation of electron microscopes (scanning and transmission). Basic research methods used in electron microscopy. Preparation used in reflection and transmission electron microscopy. Selected by advanced microscopic methods (microanalysis of chemical composition, diffractive orientation of crystallites, quantitative analysis of images and breakthroughs).
3.	**Mechanical Properties Testing of Engineering Plastics**	General characteristics of technological and endurance tests. Stress-strain relationship in a structural material. Hook's Law, material constants. Division of strength test methods depending on the nature of the load. Characteristics of strength indicators determined in laboratory tests. Static methods for measuring hardness and microhardness. Static endurance tests. Tests carried out at elevated temperatures. Fatigue and impact tests. Basics of fracture mechanics.
4.	**Physical Basis of Electro-Optical Effects in Liquid Crystals**	Physical basis of electro-optical effects in Liquid Crystals (CK). Selected optical, dielectric, flexoelectric, elastic and viscous properties of CK, interactions of the ordered CK layer with the external electric field. Basic electro-optical effects in CK such as: dynamic scattering effect, Freedericks effect, TN (Twisted Nematic) effect, STN (Super Twisted Nematic) effect. Bistable switches in Ferroelectric Liquid Crystals and tristable switches in AntiFerroelectric Liquid Crystals.
5.	**Calorimetric, thermogravimetric and volumetric methods for testing material properties**	Study of materials, in particular materials for storing hydrogen in the solid phase, using: differential calorimetry, thermogravimetry and volumetric analyses. Types of equipment, principles of operation, calibration methods, good practices of use, advantages, disadvantages, possibilities and limitations. Basics of analysis of test results, correction of results and selection of test parameters to obtain the best results.
6.	**Semiconductor materials for optoelectronic applications**	Basic properties of semiconductor materials used in the construction of optoelectronic devices: band structures, absorption coefficient, mechanisms of carrier generation and recombination, carrier mobility. Semiconductor compounds of group III-V materials used in semiconductor lasers. Group III-V nitrides used in blue optoelectronics. Solid solutions II-VI in the detection of infrared radiation. Low-dimensional quantum structures (superlattices, quantum wells, quantum dots) in the detection and generation of electromagnetic radiation. Materials for I, II and III generation photovoltaics (silicon, CdTe, CIS, CIGS, organic semiconductors).
7.	**Nano and ultracrystalline engineering materials**	Nano and ultracrystalline engineering materials – definitions and basic terms. Structural determinants of the properties of nano- and ultracrystalline materials. Methods of obtaining materials with an extremely fragmented structure. Methods of studying the structure of nano- and ultracrystalline materials. Characteristics of selected groups of materials with nano and ultracrystalline structure.
8.	**Nanoporous anodic aluminum oxide: synthesis, design and applications**	Mechanism of anodic aluminum oxide growth (ionic conductivity, basic chemical reactions, lattice stress-induced ion transport, etc.). Geometrical parameters of the anodic aluminum oxide matrix (pore diameter, pore spacing, etc.) and their relationship with the applied parameters of electrochemical synthesis (temperature, voltage, time). The process of self-organization of the matrix pores into a hexagonal system. Soft anodization. Hard anodization. Pulsed anodization. Synthesis of nanostructures using matrix-assisted methods of anodic aluminum oxide (electrochemical deposition, sol-gel, CVD, ALD methods). Applications of anodic aluminum oxide matrix (biosensors, filters, optoelectronic components, tissue engineering, etc.). New perspectives and development trends related to the production and application of anodic aluminum oxide.
9.	**Non-telecommunications applications of fiber optics**	Interference (phase) fiber optic sensor technology. Terminology used in the description of sensors, the ideology of the mathematical formalism of the sensor description along with the definition of the role of the transducer as well as optical and electronic signal processing. Methods of building sensors with a point and a distributed detection field. Multiplication of point sensors.

No.	Item Name	Curriculum content
10.	**Measurement of machine and device parts using coordinate measuring techniques**	Use coordinate measuring techniques and tactile profilometry at various stages of the production process. Metrological properties of coordinate measuring machines and tactile profilometers Programming of a multi-sensor measuring machine to carry out measurements as part of the final acceptance of machine parts and equipment manufactured in mass production conditions.
11.	**Experiment planning and data analysis using Origin and Statistica**	The use of computer programs to plan an experiment. Statistical methods. Origin and Statistica's capabilities for experiment planning and data analysis.
12.	**Basic properties of liquid crystals**	Liquid crystals as a separate state of matter. Classification of liquid crystals. Chemical structure of mesosogens. Description of the liquid crystal phase, the concept of director and the ordering parameter. Liquid crystals as a viscoelastic medium. Free energy deformation of liquid crystal. Arrangement of liquid crystals. Anisotropy of physicochemical properties of liquid crystals. Electro-optics and magneto-optics of liquid crystals. Nonlinear optics and liquid crystal acoustooptics. Applications.
13.	**Keysight Vee and Lab View for Data Control and Processing**	Basics of programming in LabView, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops (for loop, while), selection structures, feedback, etc. How to use objects of various types (numeric, string, bool), including in the form of matrices and clusters. Methods of data processing and transfer. Creating a program algorithm to control a given device according to specific assumptions. Execution of a program that controls the device in the form of a "virtual device". Expansion of the program with preset elements such as menu buttons. Basics of programming in Keysight Vee, including the logic of the so-called graphic language. Basic programming structures - sequential blocks, loops, selection structures, conditional statements, etc. A way of using objects of various types, including matrices and complex variables. Basic methods of data processing and transfer. Cooperation Keysight Vee – MS Excel. Development of own program algorithm for controlling a given device according to specific assumptions. Expansion of the program with preset elements such as a panel.
14.	**Designing technological processes for incremental Direct Deposition methods**	Design of elements of machine and equipment parts using solid and surface modeling. Rules for creating and editing and the possibility of repairing data exchange files dedicated to incremental techniques. Initial assessment of the functionality of products in the concurrent production process - defining the material, process window and generating source files for Rapid Prototyping techniques. Direct Deposition technological process design - production of the target production series
15.	**Dielectric spectroscopy**	Dielectric spectroscopy (impedance spectroscopy/radio range spectroscopy) as an experimental method in materials science and chemistry, as well as in electronics for the analysis of the properties of materials used in electronics. Electrical phenomena at the atomic, molecular, and macroscopic (medium) levels. Theoretical foundations (mathematical apparatus) of relaxation phenomena in condensed matter. Parasitic effects in impedance measurements. Research equipment (impedance analyzers), experiment and analysis of experimental data in the context of the properties of various materials.
16.	**Structural Determinants of Material Properties**	Terminology, methodology, critical reception of external data, critical evaluation of the results of solving scientific problems in the area of materials and technology. Improvement in the formulation of research assumptions, scientific goals, analysis of results and conclusions.
17.	**Modern methods of material characterization**	Basics of material characterization methods. Cleaning of materials. Densitometry. Methods for testing thermal, electrical, magnetic and optical properties. UV, IR, Raman and Mossbauer spectroscopy. Selected specialized spectroscopic methods. TEM and SEM electron microscopy. Atomic force microscopy and scanning tunneling microscopy. X-rays, electronography and neutronography. Methods for the study of photonic materials, nanomaterials and metamaterials. Material characterization track.
18.	**High-energy ball milling and mechanical synthesis**	Issues related to high-energy grinding of materials in ball mills as well as mechanical alloying. Types of ball mills, the principle of their operation, capabilities and the effects of grinding. As part of the course, tests of mechanical synthesis of alloys of selected metals and high-energy grinding of pure metals and their alloys, as well as selected ceramic materials will be carried out.

No.	Item Name	Curriculum content
19.	**Advanced materials for hydrogen storage**	Assumptions of the idea of hydrogen economy and its limitations. Characteristics of hydrogen storage methods including solid storage materials. Hydrogen storage materials based on adsorption. Low-capacity materials for storing hydrogen at room temperature. Magnesium-based hydrogen storage materials. Complex hydrides as high-capacity materials for hydrogen storage. Methods to improve the hydrogenation ability of materials. Methods for testing hydrogen storage materials.
20.	**Basics of plasmonics and metamaterials**	Basic definitions of plasmonics and metamaterials. Physical basics, interaction of electromagnetic waves of different frequencies with metamaterials in different wavelength ranges, surface plasmons, metasurfaces. Technological conditions for the implementation of metamaterial one-, two- and three-dimensional structures. Physical and technological requirements and limitations for different types of metamaterials, as well as the use of classical technologies for the production of nano- and metamaterials. Methods for simulation of the properties of selected metamaterial and plasmonic structures and methods for characterization of metamaterials and nanometre-sized structures using AFM, STM microscopy, etc. to assess the properties and shape of the SRR. Application of metamaterial structures in photonic devices and prospects for the development of nano- and metamaterials with particular emphasis on military applications.
21.	**Selected Materials and Functional Structures for Photonic Applications**	Properties and applications of such materials and structures as: optical glass and polymer substrates for the construction of electro-optical transducers, oxide and organic functional layers used as anti-reflective layers, bandstop and edge filters, transparent conductive organic and inorganic layers, nanomaterials for organic applications, photonic polymers and liquid crystals, including composite structures. Construction, construction and operation of selected photonic elements, made on the basis of, among others. the above-mentioned functional materials; spatial light modulator, dynamic wave plates, dynamic elements of diffraction optics (diffraction gratings), optical vortices, microlasers based on self-organizing structures, Kerr and Pockels cells, optical materials and elements for spatial imaging and others.
22.	**Computer Image Analysis in Materials Science**	Basics of stereology, including basic assumptions and stereological implementations. Detection methods and binarization procedures necessary for quantitative image analysis. Fundamentals of image acquisition and processing (m.in. morphological transformations, logical and arithmetic operations). Procedures carried out during computer image analysis in the study of real engineering materials.
23.	**Additive manufacturing of functional materials**	Practical aspects of additive manufacturing of functional metallic materials using LMD/LENS laser technology. Influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of functional materials.
24.	**Methods for amplifying light emission from broadband semiconductor nanostructures**	Basic types of broadband semiconductors. Properties of luminescent broadband semiconductors on specific examples (e.g. GaN, ZnO, SnO_2). Methods of synthesis of nanostructures. Modulation of optical properties of nanostructures at the synthesis stage. Post-synthetic methods of luminescence enhancement. Intentional doping of broadband semiconductors. The phenomenon of charge and energy transfer. The phenomenon of surface plasmon resonance (SPR) and localized surface plasmon resonance (LSPR). Plasmonic light gain from semiconductor nanostructures – basic criteria for coupling SPR or LSPR to the frequency of optical transitions in semiconductors at the metal/semiconductor interface.
25.	**Electrochemical synthesis of anti-reflective, super-hydrophobic coatings and photonic crystals**	Basic knowledge of the production of porous anodic aluminum oxide (AAO). Parameters of electrochemical synthesis. The phenomenon of constructive and destructive interference. Single-layer and multi-layer interference. Features of an ideal anti-reflection coating. Anti-reflective coatings with gradient refractive index. Microstructure of the moth eye. Surface wettability. High-energy vs. low-energy surfaces. Hysteresis of the contact angle. Wetting textured surfaces: Wenzel model vs. Cassie-Baxter model. General characteristics of 1D, 2D and 3D photonic crystals. Structural coloration. Inspirations drawn from nature, or what is biomimetics. Multi-step electrochemical synthesis of AAO with conical pore shapes. Electrochemical production of 1D crystals by pulsed method. Design of voltage or current pulse sequences, taking into account processes limited by diffusion and the speed of ion transport through the barrier layer. Control of electrochemical synthesis parameters to obtain the desired photonic properties of AAO-based photonic crystals.

No.	Item Name	Curriculum content
26.	**Modeling of semiconductor devices.**	The genesis of transport equations derived on the basis of the principles of behavior and postulates of thermodynamics of irreversible processes. Generation-recombination mechanisms responsible for the magnitude of charge carrier concentration. Contribution of cross-band processes and SHR mechanisms involving point defects, dislocations and surface states. Process modeling and determination of cross-sections. Mechanism of interband absorption of radiation. Construction of iterative diagrams enabling numerical solving of a system of transport equations. Record on the numeric grid. Problems related to numerical solving of nonlinear equations. He will be able to write a fragment of the program as a task to pass the subject. This fragment can be implemented into my program in order to design a specific device or to study the physical parameters of the structure.
27.	**High-entropy alloys – synthesis, structure, research and properties**	The latest group of materials – the so-called high-entropy alloys. Theoretical aspects of their formation and stability, properties, structure, synthesis methods and heat treatment. Practical attempts to synthesize and study the properties of alloys from this group.
28.	**Additive manufacturing of alloys based on intermetallic phases**	Specific aspects related to the additive manufacturing of alloys based on intermetallic phases (in particular FeAl). The influence of manufacturing parameters on the ability to shape the microstructure, structure and properties of these materials.
29.	**Combinatorial Materials Manufacturing and Testing Engineering**	Possibilities of using DED laser additive techniques for combinatorial search for new engineering materials. As part of the course, attempts will be made to synthesize both continuous and discrete alloy libraries and the possibility of their rapid study.
30.	**Reactive mechanical grinding as a method of synthesis of modern materials for storing hydrogen in the solid phase.**	Synthesis of solid-phase hydrogen storage materials using reactive hydrogen grinding in ball mills. Attempts at the synthesis of selected metal hydrides and complex hydrides and studies of the influence of synthesis conditions on its result and the properties of the produced material.
31.	**Additive techniques with elements of reverse engineering**	Devices used in reverse engineering. Editing and processing of point clouds and generation of STL files, taking into account technological specifics. Preparation for 3D printing (model positioning, material selection, degree of infill, division into layers, source code generation). Multi-variant production of models with complex geometry using FDM and SLA techniques. "Post-processing" and assessment of the quality of the obtained printouts using a 3D scanner and a micro-computed tomography.
32.	**Overview of additive techniques used in modern technology**	The idea, technical solutions and development trends of 3D printing. Overview of additive methods used in strategic industries – material, technological and economic conditions. Specifics of the processing of high-strength thermoplastics used in aviation and medicine – devices, technological parameters of 3D printing. Evaluation of the geometric and metallurgical quality of sample parts of printed machines using various additive techniques. Additive technologies and Industry 4.0.
33.	**Selected issues in 3D printing**	Analysis of the possibility of manufacturing structural elements using Rapid Manufacturing techniques. Specificity of processing advanced construction materials using laser additive forming methods. Material tests and assessment of geometric quality of printouts. Traditional vs. laser methods of regeneration of machine and equipment parts. Analysis of the possibility of reconstructing the operating indicators of machine and equipment parts using the semi-industrial LENS system – multi-criteria quality assessment.
34.	**Researcher's workshop 1 – tools for writing scientific texts**	The course introduces the student to issues related to the basic methods of creating texts describing the results of research work, including advanced use of the functions of the following programs: MS Word, LATEX, ENDNOTE, MENDELEY and practical ways of creating drawings, tables and citations. In addition, students are familiarized with the methodology of selecting the right journal and practical tips when sending manuscripts for publication in prestigious journals.
35.	**Researcher's workshop 2 – writing scientific articles**	The course introduces the student to issues related to the basic methods of designing the content of scientific articles, the vocabulary used, methods of graphic processing of results and the use of software helpful in the creation of scientific

No.	Item Name	Curriculum content
		texts. In addition, the methods of literature analysis, the ethics of creating scientific texts and the selection of author's typesetting, the basis of the methodology for processing results, as well as the possibilities of using software and services for linguistically correcting scientific texts will be presented.
36.	**Researcher's Workshop 3 – Writing Scientific Articles**	The course introduces the student to the issues related to the estimation of measurement uncertainty in scientific papers. The issues raised during the classes are focused on learning practical methods of determining uncertainty in real measurements. Theoretical aspects, i.e. the mathematical apparatus used in estimating uncertainty, is reduced to the necessary minimum. Part of the classes is intended to solve the issues reported by the students.
37.	**Quantum mechanics in examples**	The course aims to solve in detail and analyze the most important examples describing the behavior of particles in the microworld in the language of quantum mechanics. After the introduction to wave mechanics, the following examples will be analyzed: free particle; transmission (reflection) through the potential threshold; transmission (reflection) through the potential barrier (tunnel effect); an infinite pit of potential; a finite pit of potential; harmonic oscillator; the Krönig-Penney model; solving the problem of the Coulomb potential.
38.	**Corrosion testing in materials science**	Corrosion phenomenon and mechanisms of various types of electrochemical and chemical corrosion, thermodynamic determinants of corrosion phenomena: corrosion vs. passivity – Pourbaix diagrams, qualitative and quantitative methods in corrosion tests – review, polarization and polarization curve with its characteristic points and ranges, determination of corrosion current potential and density from extrapolation by the Tafel equation, chronoamperometry and determination of the initiation and propagation time of pitting in corrosion Basics of electrochemical impedance spectroscopy: equivalent circuits and real elements of materials and coatings, salt chambers, immersion tests.
39.	**Anodic oxides of copper and its alloys – production, characteristics and applications**	Synthesis and mechanism of growth of passive layers on copper, review of the methods and experimental conditions used for the production of copper oxides and hydroxides by electrochemical means, thermodynamic conditions allowing the growth of oxides and hydroxides, redeposition and growth of layers, modifications of copper oxides and hydroxides, applications of nanostructured copper oxides and hydroxides: corrosion protection, photocatalysis, electrochemical reduction of carbon dioxide to alcohols and Hydrocarbons.
40.	**Anodizing of aluminum alloys**	Structure and mechanical properties of alloys vs. corrosion resistance, corrosion failure mechanisms of common aluminum alloys, overview of industrial anodizing methods, conversion coatings vs. anodic coatings, soft, hard and plasma anodizing (PEO/MAO), hexavalent chromium problem, chromium-free alternatives used in anodizing aluminum alloys, nanoporous oxide and corrosion protection, pore closure, REACH convention vs. anodizing and pore closure, durability of anodic aluminum oxide on technical alloys, methods of quantitative treatment of corrosion of aluminum alloys after anodizing.

Annex VI.5
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: mechanical engineering

No.	Item Name	Curriculum content
1.	Numerical Analyses in Load-Bearing Structures	Theoretical foundations of numerical methods of analysis of load-bearing structures including multi-stage analyses, strategy of computer FEM simulation of two- and three-dimensional problems in the field of mechanics and strength of materials and methodology of simplification (reduction of static diagrams) of real structures enabling the creation of a correct and effective numerical model. Methods of modeling mechanical structures with particular emphasis on supporting structures using graphics preprocessors. Construction of 2D and 3D models for analysis in the field of selected engineering issues, performance of calculations with attention to the selection of optimal analysis parameters and assessment of the correctness of calculation results using analytical methods and available results of experimental tests, on the example of elements and components of vehicles, special and load-bearing structures.
2.	Autonomy of mobile robots	Introduction, definitions, components of the construction of mobile robots. Wheeled robot drive systems. Navigation and self-location of robots. Navigation with the use of markers. Odometry, methods to improve self-localization results. Determining the position of the robot based on the map. Methods of planning the path of a mobile robot. Local planning, probabilistic methods. Tasks, construction, architecture of control systems Vision systems in mobile robotics. Walking robots. Applications of autonomous mobile robots.
3.	Non-destructive testing of aircraft	Types of defects, defects and damage that threaten the safety of operation of technical facilities. Non-destructive testing methods – physical basis. Visual and penetrative methods. Ultrasound method. Acoustic methods. Eddy current method. Thermographic method. X-ray method. Shearograps and DSight. Non-destructive testing methods – advantages, disadvantages and limitations in use. Non-destructive testing certification.
4.	Biomechanics of human body movement during a road accident	Biomechanics of the human body. Human anthropometric analysis. Dynamic loads and the process of injury. Basics of building measuring dummies. Basics of human body modeling. Computer simulation of the movement of a human body model and experimental research. Calculating the risk of injury to the head, torso and thighs. Injury risk prediction models.
5.	Construction and operation of industrial robots	Construction and operation principle of industrial robots. Principles of robotization of production lines. Environments and languages for programming industrial robots
6.	Digital signal processing	Mathematical models of deterministic signals. Advanced signal sampling techniques. Selected problems of analysis of discrete signals in the time and frequency domain. Frequency resolution of digital spectral analysis algorithms. Fast weave algorithm. Selected specialized implementations of digital filters. Basics of digital filter design. Decimation and interpolation of digital signals. Digital signal spectrum conversion. Direct Digital Signal Generation Method (DDS). Program receiver.
7.	Dynamics of mechatronic system design	Issues of modeling mechatronic systems. Elements of motion and vibration analysis of linear systems with single and multiple degrees of freedom. Elements of motion analysis of nonlinear mechatronic systems. Stability testing of linear and nonlinear mechatronic systems. Self-excited vibrations. Methods of measuring vibrations of mechatronic systems.
8.	Dynamics of car movement	Modeling the movement of the car. Modeling of movement on hard, snowy and deformable surfaces. Analysis of the dynamics of rectilinear and curvilinear motion. Steerability and stability. Overcoming terrain obstacles. Wheeled and tracked chassis. Modeling the process of a car crashing into an obstacle. Analysis of vibrations and driving comfort.
9.	Dynamics and modeling of hydrostatic systems	Principles of dynamics of hydrostatic systems. Description of the dynamics of drive units and systems. Steady and transient, boot processes. Dynamic analysis and its description. Modeling of hydrostatic drive assemblies, subassemblies, elements

No.	Item Name	Curriculum content
		and systems. Open and closed systems. Modeling of hydrostatic systems in MATLAB-SIMULINK.
10.	Dynamics of multi-member systems	Theoretical foundations of numerical methods of analysis with the use of rigid bodies and the strategy of computer simulation of multibodies with the use of various algorithms for the formulation of equations of motion and their integration. Overview of multibody analysis software environments and examples of mechanical engineering solutions. Methods of modeling mechanical structures with rigid solids in planar and spatial systems. Construction of planar and spatial models with the use of various applications for the analysis of kinematics and dynamics of multi-member systems in the field of selected issues of mechanical engineering. Multivariant numerical analyses with attention to the selection of optimal calculation parameters and the assessment of the correctness of the obtained results using analytical and experimental methods.
11.	Impulse loads of motor vehicles – selected issues	Operating conditions of motor vehicles, dynamic loads – sources. Impulse loads – characteristics. Experimental and model studies of impulse loads acting on vehicles, methods and design solutions to reduce the effects of these impacts.
12.	Computer-aided operation of machines	Information needs of the operating system. Information management – information system. Characteristics of computer software. Design and operation of management information systems. Features of IT systems supporting operation management. ICT services in management.
13.	Shaping a safe car body	Body construction - shaping energy-consuming and survival zones; construction of the floor plate. Estimating the energy dissipated by the body during a crash. Materials used in body construction. Body equipment - passive and preventive safety elements. Paint coatings. Crash tests.
14.	Composite materials in mechanical engineering	Definition and classification of composite materials. Strength and performance properties of composite materials. Technologies for the production of composite materials. Research used in the experimental analysis of mechanical properties of composites. Joining composite materials. Metal-composite joints. Exploitation of composite materials. Repairs of composite structures.
15.	Finite Element Method	Selected examples of FEM applications. FEM in terms of displacement. Member structures. Triangular and quadrangular elements. Flat state of stress and strain. Axisymmetric issues. Plate and shell elements in terms of FEM. Three-dimensional elements. Selection parameters for creating an FEM mesh – criteria. Isoparametric formulation of finite elements. Shape features. Definition of start-boundary conditions. Material models in terms of FEM. Construction of the stiffness matrix. Aggregation of the global matrix. Transformations of quantities between coordinate systems. Matrix equilibrium equation. Methods of solving systems of equations. Analysis of the model and results. Basics of adaptation methods with criteria. Determination and measures of error.
16.	Methods of analysis of numerical experimental research results	Selected deterministic and stochastic examples in the research methodology allowing the use of experimental research results both in the process of validation of numerical models and verification of the obtained results using the nonlinear method of least squares, verification of statistical hypotheses, or ANOVA analysis of variance.
17.	Methods of testing the condition of machines	Basic terms and definitions. Object status. Object model. Methods of analysis and recognition of the state of the object. Classification and recognition of failure conditions of objects. Criteria and rules for the selection of decision variables. Procedures and methods of testing the condition of the machine. Selected aspects of the construction of measurement and diagnostic systems. Vibroacoustic systems for testing the condition of machines. Computed tomography of machines. The use of artificial intelligence in machine condition research.
18.	Experimental methods for investigating the thermophysical properties of solids	Thermophysical properties of solids, thermal conductivity, specific heat, thermal diffusivity, thermal expansion. Mechanical properties of solids – dynamic mechanical analysis (DMA).
19.	Methods and techniques for testing the mechanical properties of materials	Methods of testing mechanical properties under quasi-static loading. Impact tests. Methods for determining material constants. Methods of static strength tests of elastomeric and ceramic materials. Hardness and microhardness measurement methods. Methods of measuring deformations during strength tests. Methods of

No.	Item Name	Curriculum content
		testing the mechanical properties of materials under shock loading conditions. (Hopkinson test, Taylor test, ring test).
20.	Numerical Methods in Engineering Applications	Basic concepts related to numerical calculations, sources of errors. Interpolation and approximation. Differentiation and quadrature. Systems of linear equations. Algebraic eigenproblem. Methods of solving ordinary differential equations. The linear problem of least squares. Fourier analysis. Optimization elements. Information about other areas of numerical analysis (partial differential equations, stochastic methods, etc.).
21.	Numerical Methods in Mechanical Engineering	Basics of numerical methods. Interpolation polynomials. Approximation methods. Integration methods. Methods of solving systems of equations. Methods of solving nonlinear equations. Methods of solving differential equations. Application of numerical methods in mechanical engineering, including CAD/CAE systems.
22.	Methods for designing and optimizing aircraft structures	Parameterization of the geometry of aerodynamic structures, dimensionless shape coefficients. Optimization methods in application applications. Numerical optimization methods: structural modeling, shape and dimensional optimization. Stages of the optimization process. Aircraft quality indicators, task and mission modeling in the tasks of optimal aircraft design. Converging and divergent spiral design. Systems and systems that are subject to the optimization process: geometry, aerodynamics, powertrain, mission, performance, structure and mass characteristics. GRIP programming language for the Siemens NX system. The use of the GRIP language for the processes of searching for the optimal geometry of the designed optimization object using integrated design systems.
23.	Constitutive Models of Materials in FEM Analysis	Mathematical description of constitutive models of materials such as steels, alloys, rubbers, elastomers, foams, ceramics, etc. Experimental studies to determine the parameters of models. Numerical analyses using learned material models.
24.	Modelling of heat transfer processes	The subject prepares to formulate mathematical models of heat and mass transfer processes, which require solution of the boundary-value problems for systems of partial differential equations. Within the framework of lectures mechanisms of complex and coupled (conductive-radiative) heat and mass transfer, constitutive equations of Cattaneo-Vernotte and Tzou dual-phase lag models, selected analytical as well as numerical methods of solution both the direct (including phase transitions) and the inverse heat conduction problems are discussed. During tutorials and laboratory practices PhD students use practically knowledge gained in lectures to find analytical solution of simple radiative heat transfer problems and they are searching for numerical solutions of coupled heat and mass transfer problems by using their own numerical codes as well as commercial software
25.	Modeling and simulation of mechatronics issues	Principles of physical and mathematical modeling, and parametric identification of the model. Application of the Matlab/Simulink environment in the simulation of mechatronics issues
26.	Modeling and simulation of nonlinear mechanical problems	Description of the implementation of deformations of solids characterized by physical nonlinearity in the range of small and large deformations. Getting to know numerical methods for solving nonlinear problems and methods for refining the solution.
27.	Parametric modeling and structural optimization with FEM	Theoretical basis of the optimization procedure. Optimization algorithms. Methods of Structural Optimization Using FEM Structural Analysis. Methods for creating parametric FEM models using preprocessor scripts. Analysis of optimization results. Topological optimization.
28.	Flow modeling	Methods of computer modeling of flow processes in basic and applied problems of fluid motion dynamics. Simulation methods for researching streamlined issues. Basics of modeling flow processes. Conservative formulations of basic fluid dynamics equations, boundary conditions in computational problems, basic numerical schemes and the basic CFD - Fluent computational solver. Modeling of flow turbulence, including averaged Navier-Stokes equations, turbulent stress tensor, turbulence modeling capabilities and problems. Direct methods of solving turbulent movements (the so-called DNS method), the large vortex method (LES). Mapping of complex simulation study objects, construction and execution of basic operations on computational grids, analysis of the reliability and accuracy of numerical modeling results.
29.	Modeling machine motion	General principles of modeling mechanical systems. hydrostatic, electromechanical. Deterministic and random processes. Construction of simulation models. Identification of model parameters and their validation. Characteristics of basic dynamic members. Basics of dynamics of systems with variable mass.

No.	Item Name	Curriculum content
30.	Modeling composite structures	The use of laminates. Laminate configuration. Micromechanics and macromechanics of laminates. Modeling at the level of lamina and laminate. Determination of material parameters. Stiffness and strength of laminates. Strength hypotheses. Design elements and modeling of composite (laminate) structures. Strength Analysis of Composite Structure for Selected Load Conditions.
31.	Modeling of the Contact Phenomenon in Structural Mechanics	General division of contact phenomena. Mathematical foundations of the description and solution of the problem of contact. Algorithms for defining and solving the problem of contact in the environment of computer-aided engineering calculations. Use of a large-scale approach.
32.	Modeling and research of the processes of cooperation between the wheel and the road	Issues of modeling and testing the processes of cooperation between the wheel and the road to the extent necessary to model the dynamics of vehicle motion (selected mathematical models, methods and techniques of testing tire wheels on a drum stand and with the use of a test trailer).
33.	Modeling of car traffic and controls	Review of vehicle motion dynamics models and models describing the driver-vehicle-road system (models of lateral dynamics of the car in various control configurations).
34.	Modern technologies for bonding structural materials	Friction stir welding (FSW), laser beam welding (LBW), areas of application and strength properties of the cohesive joints obtained. Influence of bonding processes on the microstructure of selected construction materials. Heat and mechanical treatment of FSW and LBW cohesive joints.
35.	Modern CAD\CAM\Additive Manufacturing Design & Manufacturing Systems	Systems for computer-aided CAx design, construction and manufacturing processes. CAM technological process support systems. Additive manufacturing technology – Rapid-protytyping, Rapid-manufacturing and reverse engineering techniques.
36.	Renewable energy sources	The importance of energy in the development of modern civilization. Modern fossil-based energy sources and ecological factors. Renewable energy sources. Solar energy. Wind. Water power. Geothermal energy. Bioenergy. Energy from the use of hydrogen as the fuel of the future. Energy storage systems.
37.	CAE Engineering Software	An overview of CAE engineering support systems with an indication of their purpose and the possibility of using them in structural analyses. Preparation of numerical models for calculations in the static and dynamic range. Running calculations and presenting and processing the results obtained.
38.	Experiment planning and optimization of mechanical objects	Introduction to planning an experiment. Measurement errors and uncertainties. Characteristics of random variables. Statistical hypotheses and their verification. Correlation and regression analysis. Plan your experiment. Two-level plans. Three-level plans. Multi-level plans. Simplex plans for analysis composition – property. Criteria for the optimality of plans. Optimization of Extreme Machine Technology of Statistical Functions and Their Limitations. Methods of determining the extremum of statistical functions. Examples of experiment optimization in mechanical engineering.
39.	Basics of road safety	Basics of road safety analysis. Modeling the course of a road accident. Models of driver operation. Methods of analysis of road accidents. Safety in the movement of autonomous vehicles. Statistics of road accidents and their interpretation.
40.	Basics of Internal Combustion Engine Inlet Air Filtration in Baffle Filters	Classification of internal combustion engine intake air filters. Performance requirements for air filters. Porous filter media. Aerosol filtration mechanisms in the fibrous bed. Models of filtration efficiency and aerosol flow resistance in the pulp bed. Properties of papers and filter composite materials with the addition of nanofibers. Types and methods of shaping filtration partitions. Panel, cylindrical and core inserts. Criteria for selecting air filters for the vehicle engine. Rules for the use and operation of air filters.
41.	Basics of Internal Combustion Engine Inlet Air Filtration in Inertia Filters	Classification and characteristic values of inertial filters. Types of cyclones. Characteristic dimensions of the cyclone. Geometric parameters of cyclones. Factors determining the effectiveness of cyclones and multicyclones. Aerosol filtration process in cyclones. Forces acting on a particle in a cyclone. Condition for separation of particle from gas. Formulas for determining the grain diameter of the limit. Models of filtration efficiency and gas flow resistance in a cyclone. The influence of dust extraction from the sedimentation tank on the efficiency of the multicyclone. Criteria for the selection of inertial filters for motor vehicle engines. The essence of filtration of engine inlet air in two-stage filters.

No.	Item Name	Curriculum content
42.	Fundamentals of Mechanics of Continuous Media	Fluid mechanics in the field of statics and hydrodynamics, mechanics of a deformable solid in the field of the theory of elasticity and plasticity, modeling of materials.
43.	LabVIEW environment in experimental research	The process of creating programs in the LABVIEW environment with the use of control and measurement equipment (myRIO, sbRIO, DAQmx). Data types in LABVIEW. Complex data types in LABVIEW, Communication with measuring devices in LABVIEW. Analysis of measurement results.
44.	Starting processes of internal combustion engines	Engine starting characteristics. Characteristics of driving the crankshaft of engines. Ignition processes and fuel combustion under start-up conditions. Characteristics and models of start-up processes. Methods and devices of starting aids. Diagnostic aspects of the start-up process.
45.	Programming of control systems for unmanned working machines and robots	Introduction to the UML standard. Build relational schemas and use case schemas. Creation of control algorithms. Introduction to programming, programming devices for hydrotronic applications. Design a feedback loop. Implementation of feedback loops in control systems.
46.	Mechatronic sensors	Mathematical models of mechatronic sensors. General principles of mechatronic sensors. Methods of measurement, errors and methods of calibration of sensors.
47.	Condition monitoring systems	Sensors used in condition monitoring. Resistance strain gauge. Fiber optic sensors. Crack sensors. Data transmission. Recording and analysis of measurement data. Inference. Coupling of condition monitoring systems with the operating system and the operation system.
48.	Aircraft Operation Systems	Principles of operation and repair of military aircraft in the Republic of Poland. Harmonized European Military Airworthiness Regulations (EMAR). European Airworthiness Regulations (PART). The role of EASA and the Civil Aviation Authority in supervising the operation of aircraft. Bulletins and other documents regulating the operation.
49.	Control systems in mechanical engineering	Advanced control systems for mobile machines. Machine control system functions. Types of control systems. Development trends of sensors used in mobile machines. Vision and lidar locating and navigation systems. Satellite systems in machine control Centralized and distributed control. Intelligent communication networks. PLC control. Fuzzy logic in machine control
50.	Technologies for the production and processing of composite materials	Composites, ways of defining them, types of components that make them up, the most important methods of their production and processing, the importance of this class of materials in mechanical engineering. The structure of modern composite materials depending on the method of production and the treatment used, e.g. heat, thermo-plastic. Manufacture of ceramic matrix composites and multilayer metallic composites and achievements in the use of composites.
51.	Selected solutions in the field of automotive technology and car motion	Problems of the development of automotive technology and road traffic. Concepts of intelligent transport systems. Selected issues of modern automotive technology (progress in engine construction, development of drive systems – solutions used in modern gearboxes, all-wheel drive, adjustable and active suspensions, wheel hubs, new tire designs, lighting systems). Driver assistance systems. Self-driving cars.
52.	Theory and organization of machine operation	Processes and operation of machines. Measurement and analysis of diagnostic signals. Procedures for diagnosing machines. Features and measures of machine reliability. Reliability of repairable objects and systems. Planning the use and renewal of machines. Designing processes and operating systems. Principles of rational operation of machines.
53.	Thermomechanics of materials and studies of thermophysical properties	Phenomenological description of processes related to the accumulation and transport of energy in the manner of heat in substances and presentation of selected issues of statistical description of these phenomena to explain the nature of thermo-physical properties. Heat transfer phenomena in materials and material structures. Material properties vs. resultant and apparent properties of material structures. Methodology of testing thermo-physical properties. Thermal Analysis Methods. Methods for determining specific heat, thermal conductivity, thermal diffusivity, thermal expansion of materials and material structures.
54.	Tribology	Tribology – an interdisciplinary and multidisciplinary science. Tribological systems of machines and technical equipment. Solids and liquids as structural elements of tribological systems. Friction processes in tribological systems of machines. Processes of tribological wear of machine elements. Lubrication in tribological systems of machine components. Selected methods of friction and wear testing of machine elements. Contemporary tribological problems - from nano to tera tribology. Microsystems and nano tribological systems. Selected research

No.	Item Name	Curriculum content
		techniques of tribological microsystems. Micro/nanomechanical testing. Micro/nanotribological studies. Application of micro/nanotribological test results. Selected problems of biotribology and ecotribology.
55.	Durability of aircraft structures	Methods for determining and testing aircraft durability. Concepts of aircraft operation, factors limiting the durability of aircraft, the impact of operation on durability, measurement and monitoring of loads, methods of estimating the durability of aircraft, full-scale fatigue tests, non-destructive testing techniques in aircraft operation. Corrosion of aircraft.
56.	Introduction to the equations of mathematical physics	Formulation of mathematical models of physical processes that require the solution of limit problems for systems of partial differential equations. General principles for formulating limit problems for partial differential equations. The method of deriving equations describing convection, diffusion and wave transport is discussed. A general approach to the construction of mathematical models based on the equations of mathematical physics. The method of reducing borderline issues to a dimensionless form is discussed. Formulation of mathematical models based on mathematical physics equations.
57.	Modern machine and vehicle drive systems	Engines used to drive machines and vehicles. Piston internal combustion engines. Turbine internal combustion engines. Electric motors. Hybrid powertrains. Energy storage systems. Other energy sources for driving machines and vehicles. Ecological aspects of the use of various drive systems. Directions of development of drive systems of machines and vehicles.
58.	Modern test methods for internal combustion engines and vehicles	Identification of the purpose of research. Selection of the test method. Validation of research methods and procedures. Approval test procedure. Selected methods of homologation tests, measuring equipment. Processing of measurement results. Analysis of outliers, estimation of measurement uncertainty Analysis and presentation of research results. Calibration of measurement systems. Practical implementation of selected research methods.
59.	Selected methods and techniques of temperature measurement	Theoretical basics of temperature measurement, contact and non-contact temperature sensors (design, principle of operation), their dynamic properties and related measurement errors and calibration procedures. Types of thermometers: liquid, thermoelectric, resistive, thermistor, quartz, bimetallic, radiation, fiber optic and thermal imaging cameras. Statistical processing of measurement results
60.	Selected problems of rocket technology	Mathematical models of physical processes related to the dynamics of rocket motion. General rules for building rockets. Construction of rocket compartments with mathematical models. Computer simulation and visualization of the rocket flight path. Overloading of rockets on the flight path.
61.	Selected issues of waste gas treatment from motor vehicles	The impact of the automotive industry is influenced by the natural environment. Characterization of harmful substances. Systems and methods of motor vehicle waste gas treatment. Development tendencies in flue gas cleaning methods. Test methods and equipment for testing waste gases from internal combustion engines and vehicles. Studies on the influence of the operating condition of an internal combustion engine on the emissions of individual exhaust components and the granulometric composition of particulate matter.
62.	Selected issues of simulation of combustion processes and working processes of internal combustion engines.	Simulation tasks. Selection of the simulation method. Selected models of the work cycle of an internal combustion engine. Workflow simulation software. Procedure for simulating selected routings. Analysis and presentation of simulation results. Evaluation of simulation results. Simulation of selected working processes of internal combustion engines.
63.	Selected issues of modern programming - introduction to modern programming languages.	Introduction to programming using high-level languages. The issue of structural and object-oriented programming. Introduction to Python with basic libraries and the PyCharm environment. Creating console programs using Python. Introduction to creating GUI programs.
64.	Fatigue strength and fracture mechanics of materials and structures	Material fatigue phenomena and quantities describing the fatigue process. Basics of design and strength calculations of structures in the field of unlimited and limited fatigue life. Application of the principles of fatigue strength of materials and fracture mechanics. Fatigue test methodologies and fatigue testing equipment. Crack

No.	Item Name	Curriculum content
		development due to cyclic loads. Fatigue crack growth characteristics. Methods for evaluating the strength of cracked components
65.	Advanced methods of manufacturing products from sintered powders	Manufacturing processes of machine parts using modern methods of manufacturing engineering, including powder metallurgy.
66.	Advanced ballistics, modeling, and simulation	Development trends in the field of solid propellants and propellant systems (theoretical basis for modeling the operation of atypical propellant systems from the point of view of internal ballistics). Outflow of powder gases from the barrel during firing and their flow through the muzzle brake (description of the phenomena occurring during the outflow of gunpowder gases from the barrel during firing - transitional ballistics). Geometrical, mass-inertial and aerodynamic characteristics of missiles and rockets (theoretical basis for modeling the motion of flying objects from the point of view of external ballistics). Modeling of the impact impact of objects (theoretical foundations for analytical and numerical modeling of phenomena that are the domain of final ballistics).
67.	Advanced Mathematics	Tensor calculus basics. Vector and Euclidean space. Activities in Euclidean space. Basis and determination of the rebase matrix. The concept of a tensor. Tensor space. Base and polybase. Basic tensor operations and operations. Euclidean tensors with valence 2. Types and properties of tensors, tensor distribution. Tensor invariants. Values and majors. Scalar, vector and tensor fields. Derivative of tensor function, tensor field gradient, divergence and rotation of vector field. Stress and strain tensors. Strain energy density. Constitutive equations. Basics of calculus of variations. Functional. A variation of a functionary. Conditions of the minimum of a functional – Euler's equations. Formulation of local and global equilibrium issues
68.	Advanced modeling in structural dynamics	Methods of solving dynamic problems in computer terms. Constitutive modeling for impulse-loaded structure cases. Implementation of impulsive excitations – analytical and coupling approach. Testing the response of the structure. Description of the dynamic interaction of two bodies for the contact problem.
69.	Advanced measurement systems	Structure and organization of computer-controlled measurement systems and with procedures and selected "tools" for programming system controller controllers. concepts and basic methods of numerical calculations. Programming basics and how to use virtual instruments to collect, collect and process measurement data.
70.	Advanced Materials Testing Methods	Methods of testing materials, possibilities and limitations of various test methods based on the use of specialized equipment. Modern electron microscopy, confocal microscopy and X-ray microanalysis (qualitative and quantitative) and their practical application in mechanical engineering. Methods for investigating the macro- and microstructure of metals, their alloys and ceramic materials, and interpreting the test results obtained by various materials testing methods. Topographic contrast and its use for fractography studies, evaluation of changes in the microstructure of materials as a result of treatments, studies of powders and thin surface films. Microanalysis of phases and inclusions in materials research. Testing of material heterogeneity. Trace analysis of elements. Light microscopy in materials research. Metallography. Image analysis. Electron beam and its properties. Electron diffraction. Structure of a scanning and transmission electron microscope.
71.	Application of experimental mechanics in scientific research 1	Mechanical properties of engineering materials. Investigation of mechanical properties of materials in static tests. Elaboration of experimental research results.
72.	Application of experimental mechanics in scientific research 2	Rheological tests. Determination of material characteristics in cyclic load tests. Determination of material characteristics in shock load tests. Testing of materials at high and very high strain rates. Non-destructive testing.
73.	Application of Finite Element Method in Mechanical Wave Propagation Analysis	Issues related to wave propagation (elastic, plastic). Mathematical description of the phenomenon of mechanical wave propagation. Boundary conditions. Methods to solve the presented issue. Numerical analysis of wave propagation.
74.	Selected issues of vibration theory	Equations of motion of systems with one two degrees of freedom. Free vibrations of conservative systems. Free vibrations of non-conservative systems. Method of forces. Forced vibrations, resonance analysis. Vibrations forced by arbitrary force.

No.	Item Name	Curriculum content
		Free vibrations of discrete systems with any finite number of degrees of freedom. Frequencies and forms of vibrations. Vibrations of continuous systems.
75.	Selected issues in acoustoelectronics	Physical foundations of acoustoelectronics. Properties of volume and surface waves. Excitation and propagation of surface waves in piezoelectric materials. Analytical models of surface acoustic wave transducers. Classification of acoustic electronic components. Complex signal generation and processing technique. Selected methods of signal processing, compression receiver, generator. Sensors of physical quantities. Nonlinear Acoustic Surface Wave Components and Their Applications. Components of acoustic surface wave component technology.
76.	Numerical methods	Selected elements of linear algebra. Systems of linear equations, norms of vectors and matrices. Determining the solution of a system of linear equations - condition index. Gaussian method of numerical solving of a system of linear equations. Direct methods of numerical solving of a system of linear equations (LU distribution method, inverse matrix method). Iterative methods of numerical solving of a system of linear equations (Jacobi and Gauss-Seidler methods). A linear task of least squares. Methods for approximate solving of nonlinear algebraic equations. Interpolation with polynomials. Bonded functions. Function approximation. Integration and numerical differentiation of functions. Methods of numerical solving of ordinary differential equations.
77.	Electromagnetic field theory	Maxwell's equations; Differential form of Maxwell's equations in material media; Maxwell's equations for harmonically variable fields; Integral form of Maxwell's equations. Electromagnetic waves in an ideal dielectric; TEM type flat wave; Wave impedance and specific impedance. Electromagnetic waves in a lossy medium. Boundary conditions and energy relationships in the electromagnetic field. Power balance in the electromagnetic field in real and complex description. A real, complex and time-average Poynting vector. Wave incident obliquely on the dielectric-dielectric interface; Fresnel formulas for a plane wave falling obliquely on the boundary of two dielectric media. Reflectivity and power transmission. A wave incident perpendicularly at the dielectric-dielectric interface. Determination of reflection coefficients and power transmission for a plane wave incident perpendicularly on the boundary of two dielectric media. Electromagnetic waves in waveguides. Wave Mods. Potentials in electrodynamics and radiation from current sources; Vector and scalar potential. Delayed electromagnetic potentials. Potentials generated by localized sources. Hertz's Dipole.
78.	Quantum mechanics	Wave function and Schrödinger equation. Probabilistic interpretation of the wave function. Probability current density. Expected value. Separation of the wave equation. Quantum Mechanics Formalism; N-dimensional vector space; Space base; Scalar product; Hilbert space; Orthogonality of vectors and systems. Orthonormal bases; Linear operators; Operator equations; Matrix representation of an operator; Hermitian and unitary operators; Dirac notation. Selected solutions of the Schrödinger equation in 1D; A quantum particle in an infinite potential well. A free quantum particle. Uncertainty of Observables - Heisenberg Uncertainty Principles. Eigenvalues and eigenfunctions of a quantum harmonic oscillator. Creation and annihilation operators. Separation of the Schrödinger equation in 3D. Quantum particle in a spherical potential well in 3D. Values and eigenfunctions of the angular momentum operator. The spin theory of the electron. - Pauli matrices. Mutual uncertainty of spin components. Entangled states and non-locality. - The concept of entangled states and qubit. Their role in new quantum technologies.

Annex VI.6
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: chemical sciences

No.	Item Name	Curriculum content
1.	Analysis of Chemical Warfare Agents	General characteristics and classification of chemical warfare agents. General physical and chemical properties of CWA. Toxicological, tactical, chemical classification. Basic concepts of toxicology. Possible hazards and required health and safety rules when working with chemical warfare agents. Organophosphorus poisonous agents. Toxic agents with necrotic effect. Methods for the preparation of samples containing CW and their degradation products for analysis. Analytical methods used in the analysis of CW, their precursors and their degradation products. Analytical methods used in the analysis of CW, their precursors and their degradation products. Modern instruments for the analysis of contamination in field conditions. Using chromatography for BST analysis. Determination of sulphur mustard and its decomposition products by gas chromatography (GC-MS/MS). Identification of FOST BST and their decomposition products by liquid chromatography (LC-MS/MS).
2.	Chemistry and technology of liquid crystal materials	Molecular structure, structures and textures of CK. Elements of molecular structure and synthesis of CK compounds with thermotropic properties. Optical and dielectric properties, viscosity and elasticity constants CK. Electro-optical effects and principles of LCD operation. Chiral CK compounds, their properties and uses.
3.	Chemistry and technology of high-energy materials	Current state of knowledge in the field of chemistry and technology of modern explosives, gunpowder and rocket fuels: structural determinants of the stability and sensitivity of explosive compounds; design, fabrication and characterization of nanostructured explosive mixtures; principles and methods of changing the shape, dimensions and morphology of the surface of particles of explosive compounds; New ways to craft explosive compositions and form them into charges. design, manufacture and characterization of thermobaric explosives; design, synthesis and explosive properties of complex compounds; design, synthesis and properties of high-energy and high-nitrogen salts and ionic liquids as well as new components of complex gunpowder and rocket fuels (polymers and oxidizers).
4.	Polymer chemistry	Polymers obtained in the process of polychain reaction. Condensation polymers, polyadducts. Inorganic-organic polymers. Polymers of natural origin. Special-purpose polymers.
5.	Chemistry of heterocyclic compounds	Organic chemistry course covering saturated and aromatic heterocyclic compounds, how they are obtained, reactivity, utilization and importance. The course emphasizes the ability to plan and predict the syntheses of organic compounds that have a ring structure, where one or several carbon atoms forming the ring are replaced by an atom or atoms of another element (so-called heteroatoms). Heteroatoms are most often atoms of nitrogen, oxygen, sulfur.
6.	Chemical Foundations of Environmental Pollution	Basics of ecology. Man and the environment. Natural resources and ecological factors: temperature, radiation, air, water and soil. Humanity in the face of global challenges. The paradigm of sustainable development. Principles of green chemistry. Air pollution (acid jet, ozone depletion, greenhouse effect, London and Los Angeles smog). Sources of water pollution (municipal, industrial and agricultural pollution). The most important pollutants found in sewage. Pollution of seawater. Water treatment. Soil pollution. Types of harmful effects of human activity on soil: geomechanical, hydrological and chemical transformations, physical and biological degradation. Heavy metals, their characteristics, sources and impact on the environment and human health. Characteristics of cleaning and washing agents (soaps, detergents). Negative effects of using cleaning and washing agents. Organochlorine compounds in the environment (chlorophenols, polychlorinated biphenyls, dioxins). Pesticides. Classification of pesticides and their properties. Chemical structure of pesticides. Pesticide forms. Benefits and problems of pesticide use. Building materials (paints, adhesives, asbestos, products containing formaldehyde, oils) and their impact on the environment and human health. Volatile organic compounds (VOCs). VOC sources. Harmful effects of VOCs in the stratosphere. Pharmaceuticals and personal protective equipment in water. Classification, sources of origin, occurrence and environmental impact of drug residues. Food chemistry. Classification and characteristics of food additives (preservatives, improvers, antioxidants, flavor enhancers, sweeteners, dyes). Dietary supplements.

No.	Item Name	Curriculum content
7.	Chiral and polar liquid crystal functional materials	Basic concepts of functional and intelligent materials based on liquid crystal materials, both medium and high molecule, with particular emphasis on those with chiral and polar phases. Methods for the development of chiral liquid crystal materials (ChMCK) and polar liquid crystal materials (PMCK). Description of the basic methods confirming the structure/composition and physicochemical properties of MCC and PMCK (m.in. spontaneous polarization, tilt angle of the director, parameters of the helicoidal and helical structure, SHG, thermo-, chemo- and electro-optical response). Methods of measuring the described properties. Methods of modifying and optimizing the properties of the CMC and PMCK. Applications of the above as functional and/or intelligent materials.
8.	Physicochemical Properties of Carbon Materials	Carbon - a chemical element and macromolecule - a material with unique physical, physicochemical and chemical properties. Structure and properties of carbon materials (MWeg): single crystal graphite, graphene, natural and industrial graphite, glass-like carbon, carbon black and activated carbons, carbon and graphite fibers, fullerenes, carbon nanotubes, diamonds and diamond layers. Carbon composites. Carbon quantum dots, their production and application. Obtaining MWeg, modifying their properties and test methods. Reactivity and bioactivity of carbon materials. Prospects for the development of new carbon structures and their applications.
9.	Physicochemical aspects of the explosion	Explosion and detonation processes. Classical theory. Zeldowicz-von Neuman-Doring theory of detonation. Perfect and imperfect detonation. Detonation parameters in gases and solid explosives. Thermochemistry of explosives – codes for calculating detonation and explosion parameters. Initial parameters of shock waves at the boundary of the products of detonation and the external medium. Glaring factors of the explosion. Gust waves in the air. Impact of gust waves on people and objects – criteria, danger zones. Crushing and throwing effect of explosion. Assessment of the crushing capacity of explosives. To propel bodies with the products of detonation. The phenomenon of accumulation, designation of shrapnel hazard zones. Explosion hazard of gas mixtures.
10.	History of chemistry	Synthesis of elements in the universe, first observations and chemical achievements of antiquity (alchemy). History of chemical discoveries in the world: physical chemistry, analytical, chemical analysis, organic synthesis, food chemistry. Achievements of chemistry after 1661 (R. Boyl). Development of separation techniques and analysis and their impact on the development of views on chemistry and the structure of chemical compounds. Evolution of nomenclature and symbols of elements and chemical compounds. History of the periodic table, kinetic and thermodynamic studies. The development of chemistry and organic synthesis in the twentieth century and its impact on the emergence of molecular biology.
11.	Ionization methods in analytics	Classification of methods of ionization of chemical substances. Sources of ionization and methods of producing primary ions. Direct ionization of the analyte. Chemical ionization in positive and negative mode. Electron capture. Simple ionization detectors. Movement of ions in gases. Ion balance. Ion mobility spectrometry. Ionization of an analyte in mass spectrometry. Coupling of mass spectrometers with systems for chemical ionization – PTR-MS systems. Studies of the kinetics and thermodynamics of ionization processes. An overview of the applications of ionization methods in analytics.
12.	Methods for preparing samples for analysis	Methods of preparing samples for gas chromatography – general classification and initial discussion. Traditional methods of sample preparation for analysis compared to modern separation techniques. Solid samples: Soxhlet extraction, ultrasonic, supercritical SFE, accelerated by ASE solvents. Liquid samples: liquid-liquid extraction, solid-phase extraction (SPE), SPME micro-extraction, elimination and capture method, above-surface analysis method. Gas samples: enrichment methods by sorption, freezing and desorption techniques. New aspects of environmental sample analysis. Calibration. Certified reference materials. Discussion of the sources of systematic and accidental errors, most often made during sampling and preparation. Ways to avoid their occurrence.
13.	Spectroscopic methods	A subject for doctoral students of disciplines other than chemical sciences. Electron spectroscopy (UV-Vis), vibrational spectroscopy (IR), nuclear magnetic resonance (NMR) spectroscopy, mass spectrometry (MS). The doctoral student can additionally choose spectroscopic methods from the given group of methods: near-infrared spectroscopy (NIR), Raman spectroscopy, oscillation-rotational and rotational spectroscopy, two-dimensional nuclear magnetic resonance

No.	Item Name	Curriculum content
		spectroscopy (2D NMR), circular dichroism spectroscopy (ECD and VCD), fluorescence spectroscopy.
14.	Modeling and simulation computer programs in chemistry	Fundamentals of Computational Chemistry: Computational Assumptions and Methods. CHEMCAD program organization and basics of use. Application of CHEMCAD in chemical technology and materials engineering. Implementation of a project in the field of chemical technology using the CHEMCAD system. Organization of the SCIGRESS program and basics of use. Optimization of geometry and calculation of physicochemical properties of molecules. Modeling of chemical reactions in the gas phase and solution. Modeling of spectroscopic properties of molecules.
15.	Modern nanoporous materials	Latest developments in the field of nanostructures. Review of techniques for studying the structure, morphology, chemical composition, surface and thermal properties of nanomaterials. Nitrogen and argon adsorption as a complete method for determining specific surface area, pore volume, pore volume distribution function and surface properties of nanoporous materials. The latest developments in the field of obtaining nanoporous silica materials. The latest developments in the field of obtaining nanoporous carbon materials. Properties and application of activated carbons obtained from polymers. Organometallic networks (MOFs). Preparation and investigation of adsorption properties of graphene composite materials. Investigation of the physicochemical properties of nanoporous materials obtained by mechanochemical method. Determination of the parameters of the porous structure of materials on the basis of adsorption isotherms.
16.	Modern methods of synthesis of functional organic compounds	Introduction to functional materials – division, applications. Liquid crystals, properties, applications, liquid crystals – typical classes – correlation structure – properties. LC synthesis – synthesis of yesterday and today and synthesis of key intermediates. Synthesis of superfluorinated materials. Synthesis of positive nematics and s negative nematics. Synthesis of chiral liquid crystal compounds. OLED, OSC, OFET materials – structure, properties, applications. Organic Emission Materials – Types and Properties. Synthesis of p-type organic materials and n-type materials. Synthesis of semiconductor polymer materials and other organic functional materials
17.	Biomedical polymers and biomaterials	Definition of biomaterials, classification, role of chemical composition, working environment, properties and uses of biomaterials. Metal biomaterials. Ceramic biomaterials. Polymer biomaterials. Carbon and composite biomaterials. Modern polymer and hybrid systems used in biomedicine for diagnostic purposes (e.g. contrasts for magnetic resonance imaging) and therapeutic purposes (e.g. drug carriers).
18.	Practical Tools and Concepts for Modern Organic Synthesis	An advanced course in organic chemistry with an emphasis on acquiring the ability to plan the syntheses of complex organic compounds. The use of modern organic synthesis techniques. Chemistry of organofluorine compounds. Flow chemistry in organic synthesis. High-pressure organic reactions.
19.	Synthesis of liquid crystals	Introduction to liquid crystals, structure and anisotropic properties. Applications of liquid crystal, display and photonic materials. Methods for determining liquid crystal phases. Two-component and multi-component liquid crystal mixtures, non-additive behaviors. Superfluorinated liquid crystal materials, synthesis of fluorinated materials - a review of synthesis methods. Design of liquid crystal materials synthesis, retrosynthetic analysis in LCs synthesis, review of transition metal-catalyzed coupling methods, typical LC synthesis pathways. Purification and planning processes of multi-stage syntheses. Synthesis of chiral liquid crystal materials.
20.	Modern analytical chemistry	The importance of analytical chemistry. Application of analytical chemistry in environmental protection and in areas important for human life. Basic properties of analytical equipment. Miniaturization and mobility of analytical equipment – lab on chip. Hybrid devices. Analytical methods in Polish Standards. Trends in the development of techniques for preparing samples for analysis. Chromatography as a method of analysis of organic compounds. Chromatographic matrix columns. Biochromatography. Remote analysis methods.
21.	Advanced pyrotechnics	The latest solutions used in military and civilian pyrotechnics. Currently used reducers, oxidants, binders and modifiers. Pyrotechnic applications of high-nitrogen compounds. Modern compositions of curtain smokes active in the infrared range. Modern multi-base solid rocket fuels. Solutions used in airbag inflators. Prospective applications of pyrotechnic mixtures in medicine. Basic algorithms used in modeling

No.	Item Name	Curriculum content
		combustion processes and analytical optimization of the composition of pyrotechnic compositions.
22.	Advanced spectroscopic methods	A subject for doctoral students of the discipline of chemical sciences. Expanding the knowledge about basic spectroscopic methods: electron spectroscopy (UV-Vis), vibrational spectroscopy (NIR, IR, Raman), nuclear magnetic resonance spectroscopy (NMR), mass spectrometry (MS). Advanced spectroscopic methods, including time-resolution, two-dimensional, combined techniques.

Annex VI.7
to the Education Program at the Doctoral School of the Military University of Technology

Curriculum content for optional subjects
Scientific discipline: security studies

No.	Item Name	Curriculum content
1.	**Social research in security sciences**	Scientific approach in social research. Implications of the location of the discipline of security science in the field of social sciences. The logical-empirical nature of the social sciences. Basic research approaches in the field of theory construction, data collection and analysis. Basic concepts and elements of the research process. Theory and practice of operationalization of a research problem. Methods and techniques of quantitative and qualitative research. Non-reactive methods. Desk *research*
2.	**Statistical methods in social research**	Population and sample. Statistical features. Measurement scales. Random variables. Normal distribution. Characteristics of qualitative and quantitative characteristics. Nonparametric estimation. Parametric estimation (point and interval). Verification of statistical hypotheses. Diagram of the materiality test. Testing the normality of the distribution. Problems of analysis of the interdependence of phenomena. The research process in the social sciences and the typical structure of scientific work. The course of data collection, analysis and evaluation.
3.	**Security risk management**	Risk concept and risk management process. The concept of risk and risk management. Development of the risk management field. Risk management process. Risk measures. Types of risk in the security sector. Risk measurement in public sector entities. Risk measurement in the context of ensuring system continuity.
4.	**Security Systems Project Management**	Identification of security systems. Identification of the essence, structures and attributes of the project. Complexity of projects and processes. Criteria for process analysis and evaluation. Creating process structures. Evaluation and validation of processes. Efficiency and quality of processes. Reliability of process structures. Risk in the evaluation of projects and processes. Holistic models of evaluation and validation of security system processes and designs.
5.	**Safety Systems Engineering**	The place of systems security theory in the family of sciences. Basic concepts of system security (system status, description of system security-related states, system security indicators). Principles of mathematical modeling of system security. Component and subsystem safety. Systems security models. Systems security research. Analysis of system security. Control of safety, systems.
6.	**Safety propaedeutics**	Characteristics of the three dimensions of modern security. Advancing Security Studies. Realism and neorealism. Comparative analysis of realist currents. The theory of liberalism in explaining security challenges and threats. The theory of constructivism. The main schools of security studies "Old" and "new" wars in the interpretations of realism and constructivism.
7.	**Strategies and concepts of state security management**	The process of creating concepts and expressing the essence of safety. Ambiguity in the understanding of international security. Functional relativity of safety (awareness, relativity, environment). Verbal functional factors and ways of defining security in doctrines and strategies (comparative analysis).
8.	**Crisis management in public administration**	Contemporary concepts of crisis management (the concept of vulnerability, the concept of resilience, the concept of adaptation). The subject of crisis management. Legal basis of crisis management in Poland. Crisis management process. Basic types of threats – sources of crisis situations. A crisis situation. Crisis management system in Poland. Effectiveness in crisis management.
9.	**Universal safety**	The essence of public safety. General security and national security. Mechanisms shaping public safety. Rescue. Civil protection. Civil Defense. Fire protection. Critical infrastructure protection. Organization of the protection of human life and health, material and cultural goods and the natural environment Methods and tools used to ensure public security in Poland and the EU.
10.	**Internal security**	Perception of security. Political determinants of internal security. Institutional system of internal security. Administrative police in the internal security system. Private entities in the organization of internal security. Organization of security in the region. Organization of security in the district. Organization of security in the district.
11.	**Threat intelligence**	The importance of threat analysis for research and practical activities in the field of security. Basic concepts and definitions in the field of threats. Identification,

No.	Item Name	Curriculum content
		typology, taxonomy of threats. Quantification and measurement of threats. Assess hazard probabilities, hazard impacts, and hazard risks. Threat management.
12.	**Survey data analysis**	Creating measurement tools. Sampling. Preliminary analysis. Schedule analysis. Contingency tables, boundary and conditional distributions. Analysis of single-choice and multiple-choice questions. Significance and strength of the relationship between nominal and ordinal variables. Hypothesis testing.
13.	**Multivariate analyses**	Methods of graphical presentation of multidimensional data. Multiple regression analysis. Analysis of canonical correlations. Principal components analysis. Exploratory Factor Analysis (EFA). Multidimensional scaling. Linear ordering. Cluster analysis.
14.	**Evaluation research procedures**	The concept of evaluation research. History and institutionalization of evaluation research. Types of evaluation research – the concepts of "impact assessment", "action research". Differentiation of evaluation research in terms of their social functions. Experimental designs in evaluation studies. The Concept of Experimental Society by A. Etioni. Monitoring and evaluation. Elements of cost-benefit analysis in evaluation research. Measurement problems in evaluation research.
15.	**Logic and theory of argumentation**	Logical argumentation. Deductive, reductive and inductive inferences. Diagrams and argumentation diagrams. Recognizing arguments. Diagram. Classified premises and conclusions. Elements of the evaluation of argumentation. Acceptability of premises. Reliability of sources. Relevance.
16.	**Forecasting and simulations in security**	Forecasting and social practice. Social premises for predicting behavior. Forecast vs. decision-making. Model methods. Extrapolation of trends. Validity, admissibility and error of the forecast. Forecasting based on time series. Forecasting based on econometric models. Heuristic forecasting models. Social simulations.
17.	**Modern technologies in security**	Know-how, modern technologies and their importance in ensuring safety. Modern technologies in the defense and protection system. Modern technologies in the economic security system of the state. Modern technologies in the social security system. The use of modern safety technologies in electricity generation, in the transport system, in the protection of critical infrastructure, in the protection of the natural environment.
18.	**Philosophy of security sciences**	Origins, subject and branches of philosophy and philosophy of security as the most general knowledge about security. The genesis and types of human knowledge in philosophical discourse (sources: mystical, intuitive, philosophical and scientific; types: scientific, theoretical, practical and intuitive). The logic of scientific discovery, revolution in science and the progress of knowledge in the view of contemporary epistemology. Semantic analytics of the name security and types of its understanding – the essence of security in philosophical terms. A natural and conventional concept of security. Materialistic, idealistic and realistic concepts in the hermeneutic anchoring of security. The Praxeological Concept of the Four Simple Acts and Universal Methods of Shaping Security. Tendencies in Broadening, Deepening and Thickening Security Studies The Method of War, Peace, Non-Peace and Non-War in Praxeological Approach. Philosophical problems of security in contemporary societies of control and surveillance from the perspective of dataism and technohumanism.
19.	**Modern terrorism**	Basic concepts and their meaning. The origins of terrorism. Causes of modern terrorism. The main factors generating and escalating terrorism. Systematization of the causes of terrorism. A triad of terrorist motivation. Key elements and types of terrorist threat. The scope and nature of terrorism at the beginning of the 21st century. Effects of terrorism. Preventing and combating terrorism.
20.	**Morale and Security Culture in National and International Relations**	The essence and importance of the security culture (KB) and morale (M) of physical and legal entities in internal and international relations. Psychosocial and praxeological models and "mechanisms" of KB and M functioning – relations between them. Safety culture (KB) and morale as types of key resources and competitive advantage factors in "normal" and crisis situations. Security culture as an interface integrating the security areas in question and the national security system (SBN). Intuitive and scientific ways of diagnosing and improving KB and M. Security culture and morale in times of information warfare and asymmetric conflicts

No.	Item Name	Curriculum content
21.	**Safety history**	Military, political and economic security of medieval Polish and the Polish-Lithuanian Commonwealth until its collapse. The main problems of European security in the nineteenth century. Polish national uprisings of the nineteenth century. World War I. Determinants of international security in the interwar period. Military, political, economic and social security of the Republic of Poland (1918–1939). World War II. International security in the second half of the twentieth century. U.S.-USSR relations and their impact on international security. Military, political and economic security of Poland after World War II.
22.	**Strategic communication**	Characteristics of strategic communication (terminology, essence, responsibility in NATO). Public diplomacy (terminology, essence, structures). Informing the public (terminology, essence, structures). Information operations (methods, views of NATO, views and structures of the USA, Polish views). Psychological operations (methods and techniques of action, US structures, German structures, Polish structures, British structures).
23.	**Political security sector**	Political security. Concepts. Political security in security sciences. Forms and types of political threats as well as determinants and research of political security. A model of institutionalization of political security. The need for citizen security and the tasks of a democratic state. The crisis of civic identity. Power as a factor of security. Security strategy as an instrument of political security. The influence of interest groups on political decisions. Media – shaping public opinion. The basic dilemma of political security.
24.	**Shaping military security in the 21st century**	Characteristics of military security of selected states and associations of states in relation to the methodology of identification and description of challenges, and thus potential opportunities and threats to the existence and development of individual societies. The terminology of military security, the components of this security, the impact of these elements on the state and process of military security in the face of identified and described challenges (opportunities and threats) in the perspective of the current century.
25.	**Information security**	Definitions and interpretation of the basic terms: threat, vulnerability, security, incident, information security. Basic processes of information asset protection: authentication, authorization, accounting. Formal models: Bella-LaPauduli, Biby, Shiver-Wilson, Brewer-Nash. Basic security claims. Security policy, main objectives and challenges. Risk management and assessment of the state of protection of information resources.
26.	**The economic dimension of safety**	Defining economic security and its dimensions. Economization of state security. Typology of threats to economic security. The state and the national economy in the face of contemporary cultural and civilizational changes. Economic aggression in international relations. Financial crises. Activities of transnational corporations. Technological espionage as a threat to economic security. State activity to ensure economic security.
27.	**Energy security in the face of socio-economic transformation**	The impact of socio-economic transformation on the functioning of the energy sector of developing and developed countries, and thus also on the energy security of these countries. A parallel process of influencing the way the energy industry operates, as well as the functioning of the energy security sector to protect the industry against threats (both old and new, generated by current socio-economic changes).
28.	**Social Determinants of the Security of Modern States**	The essence of social security. Social security and the model of the state system. Mechanisms shaping social security. Concepts of social security. Models of social security in the EU. Problems of social security in Poland and ways to overcome them. EU activities for social security.
29.	**Environmental security on a global, regional and national scale**	Types of challenges (opportunities and threats) generated by climate change in the area of environmental security. Identification of the impact of climate change on the national security of selected societies on a national, regional and global scale.
30.	**Cultural security factors**	Culture: concept, categories, identity. Cultural security: conceptual aspects, cultural security in the area of spiritual culture, security in the area of material culture. Cultural threats to the security of the Republic of Poland. The cultural security system of the Republic of Poland. Cultural aspects of international relations. The Cultural Background of International Conflicts. Security Culture – National and International Aspects

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 04/SDR/2019 of 2 October 2019

on the determination of the template of the Individual Education Programme for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 4 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 13/RKR/2019 of 23 May 2019. on the granting of the Organisational Regulations of the Doctoral School of the Military University of Technology, in connection with § 9 section 5 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is hereby resolved: as follows:

§ 1

1. A template of the Individual Education Programme for doctoral students of the Military University of Technology Doctoral School, which is attached to the decision, is hereby defined.
2. The template referred to in paragraph 1 shall be valid from the academic year 2019/2020.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD Eng.

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 04/SDR/2019
of 2 October 2019

APPROVED

Warsaw, ...

……..……
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL EDUCATION PROGRAM (IPK) No. .....[1]

1. Name and surname of the PhD student: .....
2. Scientific discipline: .....
3. Year of commencement of education at the Doctoral School:.....
4. Title/degree, name and surname of the supervisor(s):

   ……

   ……
5. Statements of the teaching load of a doctoral student

Lp.	Specification	Number of hours/ months of internship	Number of ECTS credits	Comments
1	**Optional subjects taught at WAT**			
2	**Optional courses taught at another university or scientific institution, domestic or foreign**			
3	**Internships at WAT**			
4	**Professional internship at another university or scientific institution, domestic or foreign**			
	Together			

[1] In the case of making changes to the IPK, a subsequent ordinal number is assigned; No. 1 concerns the first IPK

Detailed aspects of the teaching burden of a doctoral student

Lp.	Specification	Item Name	Number of hours	Comments
1	Didactic classes as part of optional subjects conducted at WAT in a foreign language			
2	Didactic classes conducted using distance learning methods and techniques			
Together				

6. Information on the changes introduced in relation to the previous version of the IPK

……

……

……

……

Date and legible signature of the doctoral student

The Individual Education Program has been prepared in consultation with the supervisor(s).

……

Date and legible signature of the supervisor(s)

Attachments

Appendix no. 1 Optional subjects taught at WAT
Appendix no. 2 - Optional subjects carried out at another university or scientific institution, national or foreign
Appendix 3 - Apprenticeships
Appendix 4 - Learning outcomes at level 8 of the Polish Qualifications Framework to be achieved as a result of the implementation of the IPK

Date of submission	Signature of an employee of the Doctoral School

Appendix No. 1
to the Individual Education Program

Optional subjects taught at WAT

Lp.	item	symbol of scientific discipline	total hours / ECTS points		Number of ECTS credit hours per semester											
					III		IV		V		VI		VII		VIII	
			Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS
The number of hours of classes requiring the direct participation of academic teachers.																

Symbol of scientific discipline:
E - Automation, Electronics and Electrical Engineering, **I** - Technical Informatics and Telecommunications**, B** - Civil Engineering and Transport**, N** - Materials Engineering**,**
M - Mechanical Engineering**, R** - Safety Sciences**, C** - Chemical Sciences

Appendix No. 2
to the Individual Education Program

Courses taught at another university or scientific institution, national or foreign

Lp.	Name of the university or scientific institution (city, country)	Item Name	Program content	Implementation semester	Number of hours	Number of ECTS credits	Comments
1							
2							
3							
4							
5							

Appendix No. 3
to the Individual Education Program

Internships at WAT

Lp.	Semester of education	Number of hours of professional practice in the form of:		Total number of hours in an academic year *(max. 60 hours)*	Number of ECTS credits
		conducting didactic classes by a doctoral student	participation of the doctoral student in teaching		
1	**II**				
2	**III**				
3	**IV**				
4	**V**				
5	**VI**				
6	**VII**				
7	**VIII**				
Together					

Professional internship at another national or foreign university or scientific institution

Lp.	Name of the university or scientific institution (city, country)	Duration	Purpose, tasks	Number of ECTS credits	Comments
1					
2					
3					
4					
5					

Appendix No. 4
to the Individual Education Program

Learning outcomes to be achieved as a result of the implementation of the Individual Education Programme (IPK)

Reference to the learning outcomes included in the Curriculum of the Doctoral School of the Jarosław Dąbrowski Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 36/WAT/2019 of 30 May 2019 on the establishment of the "Curriculum of the Doctoral School of the Jarosław Dąbrowski Military University of Technology"

Symbol number effect	Expected learning outcomes	code 8 PRK	IPK YES/NO
	Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	*P8S_WG*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_WG*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*	
D_W03	*development trends in the scientific discipline*	*P8S_WG*	
D_W04	*methodology of scientific research*	*P8S_WG*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	*P8S_WG*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*	
	Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	*P8S_UK* *P8S_UU*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	*P8S_UW*	
D_U02	*create new elements of scientific and creative achievements*	*P8S_UW*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	*P8S_UW*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	*P8S_UW*	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	*P8S_UW*	

Symbol number effect	Expected learning outcomes	code 8 PRK	IPK YES/NO
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	*P8S_UK*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*	
D_U09	*initiate a debate*	*P8S_UK*	
D_U10	*participate in scientific discourse*	*P8S_UK*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	*P8S_UK*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	*P8S_UU*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	*P8S_UU*	
	Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	*P8U_KK*	
D_K02	*taking up challenges in the professional and public spheres, taking into account: – their ethical dimension, – responsibility for their consequences and shaping models of appropriate conduct in such situations,*	*P8U_KK*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8S_KK*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	*P8S_KK*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	*P8S_KK*	
D_K06	*fulfilling the social obligations of researchers and creators*	*P8S_KO*	
D_K07	*initiating activities for the public interest*	*P8S_KO*	
D_K08	*think and act in an entrepreneurial way*	*P8S_KO*	
D_K09	*maintaining and developing the ethos of research and creative environments, including: − conducting scientific activity in an independent manner, − respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8S_KR*	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 2/SDR/2021 of 21 January 2021

on the determination of the template of the Individual Education Programme for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, in connection with § 9 section 5 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019 in on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

A template of the Individual Education Programme for doctoral students of the Military University of Technology Doctoral School, which is attached to the decision, is hereby defined.

§ 2

The decision enters into force on the day of signing.

§ 3

The decision of the Director of the Military University of Technology Doctoral School No. 04/SDR/2019 of 2 October 2019 on the determination of the template of the Individual Education Program for doctoral students of the Military University of Technology Doctoral School is no longer in force.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 2/SDR/2021
of 21 January 2021

APPROVED Warsaw, ...

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL EDUCATION PROGRAM (IPK) No. .....[1]

1. Name and surname of the PhD student: .....
2. Scientific discipline: .....
3. Year of commencement of education at the Doctoral School:.....
4. Title/degree, name and surname of the supervisor(s):

   ……

   ……
5. Statements of the teaching load of a doctoral student

Lp.	Specification	Number of hours/ months of internship	Number of ECTS credits	Comments
1	**Optional subjects taught at WAT[2]**			
2	**Courses taught at another university or scientific institution, national or foreign**			
3	**Internships at WAT[3]**			
4	**Other forms of education[4]**			
	Together			

[1] in the case of changes to the IPK, a subsequent ordinal number is assigned; No. 1 concerns the first IPK
[2] minimum 100 hours in SEM. III-VII
[3] in the form of conducting classes or participating in conducting them - min. 20 hours in Sem. III-VII, max 60 hours in an academic year
[4] internships, internships carried out in and outside the WAT at another university or scientific institution, domestic or foreign

6. Detailed aspects of the teaching burden of a doctoral student

Lp.	Specification	Item Name	Number of hours	Comments
1	Didactic classes conducted in a foreign language as part of optional subjects at WAT and subjects outside WAT			
2	Didactic classes conducted using distance learning methods and techniques, e.g. through MS Teams			
Together				

6. Information on the changes introduced in relation to the previous version of the IPK

……

……

……

……

Date and legible signature of the doctoral student

The Individual Education Program has been prepared in consultation with the supervisor(s).

……

Date and legible signature of the supervisor(s)

Attachments

Appendix no. 1 Optional subjects taught at WAT
Appendix no. 2 - Courses taught at another university or scientific institution, domestic or foreign
Appendix no. 3 - Internships at WAT
Appendix 4 – Other forms of education
Appendix 5 - Learning outcomes at level 8 of the Polish Qualifications Framework to be achieved as a result of IPK implementation

Date of submission	Signature of an employee of the Doctoral School

Appendix No. 1
to the Individual Education Program

Optional subjects taught at WAT – sem. III-VII

Lp.	item	symbol of scientific discipline	total hours / ECTS points		Number of hours and ECTS credits per semester									
					III		**IV**		**V**		**VI**		**VII**	
			Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS
The number of hours of classes requiring the direct participation of academic teachers.														

Symbol of scientific discipline:
E - Automation, Electronics and Electrical Engineering, **I** - Technical Informatics and Telecommunications**, B** - Civil Engineering and Transport**, N** - Materials Engineering**,**
M - Mechanical Engineering**, R** - Safety Sciences**, C** - Chemical Sciences

Appendix No. 2
to the Individual Education Program

Courses taught at another university or scientific institution, domestic or foreign – sem. III-VII

Lp.	Name of the university or scientific institution (city, country)	Item Name	Program content	Implementation semester	Number of hours	Number of ECTS credits	Comments
1							
2							
3							
4							
5							

Appendix No. 3
to the Individual Education Program

Internships at WAT – sem. III-VII

Lp.	Semester of education	Number of hours of professional practice in the form of:		Total number of hours in an academic year *(max. 60 hours)*	Number of ECTS credits
		conducting didactic classes by a doctoral student	participation of the doctoral student in teaching		
1	**III**				
2	**IV**				
3	**V**				
4	**VI**				
5	**VII**				
Together					

Appendix No. 4
to the Individual Education Program

Other forms of education carried out at WAT and outside WAT - at a university or scientific institution, domestic or foreign - sem. III-VII

Lp.	Name of the university or scientific institution (city, country)	Duration	Purpose, tasks	Number of ECTS credits	Comments
1					
2					
3					
4					
5					

Appendix No. 5
to the Individual Education Program

Learning outcomes to be achieved as a result of the implementation of the Individual Education Programme (IPK)

Reference to the learning outcomes included in the Curriculum at the Jarosław Dąbrowski Military University of Technology Doctoral School

Symbol number effect	Expected learning outcomes	code 8 PRK	IPK YES/NO
	Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	*P8S_WG*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_WG*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*	
D_W03	*development trends in the scientific discipline*	*P8S_WG*	
D_W04	*methodology of scientific research*	*P8S_WG*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	*P8S_WG*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*	
	Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	*P8S_UK* *P8S_UU*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	*P8S_UW*	
D_U02	*create new elements of scientific and creative achievements*	*P8S_UW*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	*P8S_UW*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	*P8S_UW*	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	*P8S_UW*	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	*P8S_UK*	

Symbol number effect	Expected learning outcomes	code 8 PRK	IPK YES/NO
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*	
D_U09	*initiate a debate*	*P8S_UK*	
D_U10	*participate in scientific discourse*	*P8S_UK*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	*P8S_UK*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	*P8S_UU*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	*P8S_UU*	
	Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	*P8U_KK*	
D_K02	*taking up challenges in the professional and public spheres, taking into account: – their ethical dimension, – responsibility for their consequences and shaping models of appropriate conduct in such situations,*	*P8U_KK*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8S_KK*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	*P8S_KK*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	*P8S_KK*	
D_K06	*fulfilling the social obligations of researchers and creators*	*P8S_KO*	
D_K07	*initiating activities for the public interest*	*P8S_KO*	
D_K08	*think and act in an entrepreneurial way*	*P8S_KO*	
D_K09	*maintaining and developing the ethos of research and creative environments, including: − conducting scientific activity in an independent manner, − respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8S_KR*	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 2/SDR/2022 of 11 January 2022

on the determination of the template of the Individual Education Programme for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, in connection with § 9 section 2 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 in on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

A template of the Individual Education Programme for doctoral students of the Military University of Technology Doctoral School, which is attached to the decision, is hereby defined.

§ 2

The decision enters into force on the day of signing.

§ 3

The decision of the Director of the Military University of Technology Doctoral School No. 2/SDR/2021 of 21 January 2021 on the determination of the template of the Individual Education Program for doctoral students of the Military University of Technology Doctoral School is no longer in force.

Director
Doctoral School

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 2/SDR/2022
of 11 January 2022

APPROVED Warsaw, ...

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL CURRICULUM (IPK) No. .....[1]

1. Name and surname of the doctoral student

2. Year of commencement of education at the Doctoral School - scientific discipline

3. Title/degree, name of the supervisor(s)

4. Statements of the teaching load of a doctoral student

Lp.	Specification	Number of hours	Number of ECTS credits	Comments
1	**Optional subjects taught at WAT[2]**			
2	**Courses taught at another university or scientific institution, national or foreign**			
3	**Internships at WAT[3]**			
4	**Other forms of education**			
	Together[4]			

[1] in the case of changes to the IPK, a subsequent ordinal number is assigned; No. 1 concerns the first IPK
[2] subjects selected from the optional modules of the "Curriculum of Education at the Doctoral School of the Military University of Technology" – min. 200 hours and min. 20 ECTS credits or min. 100 hours and min. 10 ECTS points provided that courses outside the WAT or other forms of education in the amount of min. 10 ECTS credits
[3] in the form of conducting classes or participating in conducting them - min. 20 hours in Sem. III-VII, max. 60 hours per academic year, 1 ECTS credit, regardless of the number of hours of practice
[4] the sum of ECTS points must be min. 21 points

5. Detailed aspects of the teaching burden of a doctoral student

Lp.	Name of the subject/other form of education	Language of instruction	Number of hours	Number of ECTS credits	Comments
Subjects or other forms of education taught in a foreign language at WAT and outside WAT					
1					
2					
3					
4					
5					
	Together				
Subjects or other forms of education conducted outside the WAT with the use of distance learning methods and techniques (e-learning)					
1					
2					
3					
4					
5					
	Together				

6. Information on the changes introduced in relation to the previous version of the IPK[5]

……
date and legible signature of the doctoral student

I accept the individual education program[6]

……
date and legible signature of the supervisor(s)

Attachments

Appendix no. 1 - Optional subjects taught at WAT
Appendix no. 2 - Courses taught at another university or scientific institution, domestic or foreign
Appendix no. 3 - Internships at WAT
Appendix no. 4 - Other forms of education provided at WAT and outside WAT at a national or foreign institution
Appendix 5 - Learning outcomes to be achieved as a result of IPK implementation

Date of submission	*signature of an employee of the Doctoral School*

[5] indication of changes, e.g. a new subject has been introduced/removed, a different form of education, hours of professional practice, the semester of course implementation has been changed, practice, etc.

[6] Each attachment must be initialled by the supervisor(s)

Appendix No. 1
to the Individual Education Program

Optional subjects taught at WAT

Lp.	Item Name	Symbol of scientific discipline[7]	Total number of hours/ECTS credits		Number of hours and ECTS credits per semester									
					III		IV		V		VI		VII	
			Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
Together														
Number of hours of classes requiring the direct participation of the course teacher														

[7] symbol of the scientific discipline: **E** - Automation, Electronics and Electrical Engineering, **I** - Technical Informatics and Telecommunications, **B** - Civil Engineering and Transport, **N** - Materials Engineering, **M** - Mechanical Engineering, **R** - Safety Sciences, **C** - Chemical Sciences

Appendix No. 2
to the Individual Education Program

Courses taught at another university or scientific institution, domestic or foreign – sem. III-VII

Lp.	Name of the university or scientific institution (city, country)	Item Name	Core Curriculum Issues	Semester of education	Number of hours	Number of ECTS credits[8]	Comments
1.							
2.							
3.							
4.							
5.							
				Together			

[8] the number of ECTS credits should be determined according to the conversion rate for 10 hours – 1 ECTS point for domestic classes and 2 ECTS points for foreign classes

Appendix No. 3
to the Individual Education Program

Internship at WAT (min. 20 hours)

Lp.	Semester of education	Number of hours of professional practice in the form of:		Total number hours in an academic year *(max. 60 hours)*
		conducting didactic classes by a doctoral student	participation of the doctoral student in teaching	
1.	III			
2.	IV			
3.	V			
4.	VI			
5.	VII			
Together				

Appendix No. 4
to the Individual Education Program

Other forms of education carried out in WAT and outside WAT at a university or domestic or foreign institution - sem. III-VII

Lp.	Name of the university or institution (city, country)	Name of the form of education[9]	Purpose, tasks	Implementation semester[10]	Number of hours	Number of ECTS credits[11]	Comments[12]
1.							
2.							
3.							
4.							
5.							
				Together			

[9] internship, internship, training, summer school, seminar series, e-learning classes, open lectures, etc.
[10] if completed for more than one semester, enter the number of hours for each semester
[11] in the case of implementation for more than one semester, the total number of ECTS credits must be entered, the number of ECTS credits is determined by the supervisor
[12] enter the number of months/weeks/days

Appendix No. 5
to the Individual Education Program

Learning outcomes to be achieved as a result of IPK implementation[13]

Symbol number effect	Assumed learning outcomes	*The learning effect will be achieved as a result of the implementation of subjects/practice/ other forms of education included in the IPK[14]*
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	
D_W03	*development trends in the scientific discipline*	
D_W04	*methodology of scientific research*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	
Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	
D_U02	*create new elements of scientific and creative achievements*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	

[13] reference to the learning outcomes included in the Curriculum at the Jarosław Dąbrowski Doctoral School of the Military University of Technology in accordance with the results of the 8th level of the Polish Qualifications Framework

[14] YES should be taken only if the assumed learning effect will be achieved as a result of the implementation of IPK – forms of education included in Annexes 1-4

Symbol number effect	Assumed learning outcomes	*The learning effect will be achieved as a result of the implementation of subjects/practice/ other forms of education included in the IPK[14]*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	
D_U09	*initiate a debate*	
D_U10	*participate in scientific discourse*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	
Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	
D_K02	*taking up challenges in the professional and public spheres, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations,*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	
D_K06	*fulfilling the social obligations of researchers and creators*	
D_K07	*initiating activities for the public interest*	
D_K08	*think and act in an entrepreneurial way*	
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 17/SDR/2022 of 2 December 2022

on the determination of the template of the Individual Education Programme for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, in connection with § 9 section 2 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 in on the adoption of the "Regulations of the Doctoral School of the Military University of Technology" (i.e. Announcement of the Rector of the Military University of Technology No. 4/WAT/2022 of 5 October 2022) and the Regulation of the Minister of Education and Science of 11 October 2022 on scientific fields and disciplines and artistic disciplines (Journal of Laws of 2022, item 2202), it is hereby decided that as follows:

§ 1

A template of the Individual Education Programme for doctoral students of the Military University of Technology Doctoral School, which is attached to the decision, is hereby defined.

§ 2

The decision of the Director of the Military University of Technology Doctoral School No. 2/SDR/2022 of 11 January 2022 on the determination of the template of the Individual Education Program for doctoral students of the Military University of Technology Doctoral School is no longer in force.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the WAT Doctoral School No. 17/SDR/2022
of 2 December 2022

APPROVED Warsaw, ...

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL CURRICULUM (IPK) No. .....[1]

1. Name and surname of the doctoral student

2. Year of commencement of education at the Doctoral School - scientific discipline

3. Title/degree, name of the supervisor(s)

4. Statements of the teaching load of a doctoral student

Lp.	Specification	Number of hours	Number of ECTS credits	Comments
1	**Optional subjects taught at WAT[2]**			
2	**Courses taught at another university or scientific institution, national or foreign**			
3	**Internships at WAT[3]**			
4	**Other forms of education**			
	Together[4]			

[1] in the case of changes to the IPK, a subsequent ordinal number is assigned; No. 1 concerns the first IPK
[2] subjects selected from the optional modules of the "Curriculum of Education at the Doctoral School of the Military University of Technology" – min. 200 hours and min. 20 ECTS credits or min. 100 hours and min. 10 ECTS points provided that courses outside the WAT or other forms of education in the amount of min. 10 ECTS credits
[3] in the form of conducting classes or participating in conducting them - min. 20 hours in Sem. III-VII, max. 60 hours per academic year, 1 ECTS credit, regardless of the number of hours of practice
[4] the sum of ECTS points must be min. 21 points

5. Detailed aspects of the teaching burden of a doctoral student

Lp.	Name of the subject/other form of education	Language of instruction	Number of hours	Number of ECTS credits	Comments
Subjects or other forms of education taught in a foreign language at WAT and outside WAT					
1					
2					
3					
4					
5					
	Together				
Subjects or other forms of education conducted outside the WAT with the use of distance learning methods and techniques (e-learning)					
1					
2					
3					
4					
5					
	Together				

6. Information on the changes introduced in relation to the previous version of the IPK[5]

……
date and legible signature of the doctoral student

I accept the individual education program[6]

……
date and legible signature of the supervisor(s)

Attachments

Appendix no. 1 - Optional subjects taught at WAT
Appendix no. 2 - Courses taught at another university or scientific institution, domestic or foreign
Appendix no. 3 - Internships at WAT
Appendix no. 4 - Other forms of education provided at WAT and outside WAT at a national or foreign institution
Appendix 5 - Learning outcomes to be achieved as a result of IPK implementation

Date of submission	*signature of an employee of the Doctoral School*

[5] indication of changes, e.g. a new subject has been introduced/removed, a different form of education, hours of professional practice, the semester of course implementation has been changed, practice, etc.

[6] Each attachment must be initialled by the supervisor(s)

Appendix No. 1
to the Individual Education Program

Optional subjects taught at WAT

Lp.	Item Name	Symbol of scientific discipline[7]	Total number of hours/ECTS credits		Number of hours and ECTS credits per semester									
					III		IV		V		VI		VII	
			Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS	Hours.	ECTS
1.														
2.														
3.														
4.														
5.														
6.														
7.														
8.														
9.														
10.														
11.														
12.														
13.														
14.														
15.														
Together														
Number of hours of classes requiring the direct participation of the course teacher														

[7] symbol of the scientific discipline: **E** - Automation, Electronics, Electrical Engineering and Space Technologies, **I** - Technical Informatics and Telecommunications, **B** - Civil Engineering, Geodesy and Transport, **N** - Materials Engineering, **M** - Mechanical Engineering, **R** - Safety Sciences, **C** - Chemical Sciences

Appendix No. 2
to the Individual Education Program

Courses taught at another university or scientific institution, domestic or foreign – sem. III-VII

Lp.	Name of the university or scientific institution (city, country)	Item Name	Core Curriculum Issues	Semester of education	Number of hours	Number of ECTS credits[8]	Comments
1.							
2.							
3.							
4.							
5.							
				Together			

[8] the number of ECTS credits should be determined according to the conversion rate for 10 hours – 1 ECTS point for domestic classes and 2 ECTS points for foreign classes

Appendix No. 3
to the Individual Education Program

Internship at WAT (min. 20 hours)

Lp.	Semester of education	Number of hours of professional practice in the form of:		Total number hours in an academic year *(max. 60 hours)*
		conducting didactic classes by a doctoral student	participation of the doctoral student in teaching	
1.	III			
2.	IV			
3.	V			
4.	VI			
5.	VII			
Together				

Appendix No. 4
to the Individual Education Program

Other forms of education carried out in WAT and outside WAT at a university or domestic or foreign institution - sem. III-VII

Lp.	Name of the university or institution (city, country)	Name of the form of education[9]	Purpose, tasks	Implementation semester[10]	Number of hours	Number of ECTS credits[11]	Comments[12]
1.							
2.							
3.							
4.							
5.							
				Together			

[9] internship, internship, training, summer school, seminar series, e-learning classes, open lectures, etc.
[10] if completed for more than one semester, enter the number of hours for each semester
[11] in the case of implementation for more than one semester, the total number of ECTS credits must be entered, the number of ECTS credits is determined by the supervisor
[12] enter the number of months/weeks/days

Appendix No. 5
to the Individual Education Program

Learning outcomes to be achieved as a result of IPK implementation[13]

Symbol number effect	Assumed learning outcomes	*The learning effect will be achieved as a result of the implementation of subjects/practice/ other forms of education included in the IPK[14]*
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	
D_W03	*development trends in the scientific discipline*	
D_W04	*methodology of scientific research*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	
Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	
D_U02	*create new elements of scientific and creative achievements*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	

[13] reference to the learning outcomes included in the Curriculum at the Jarosław Dąbrowski Doctoral School of the Military University of Technology in accordance with the results of the 8th level of the Polish Qualifications Framework

[14] YES should be taken only if the assumed learning effect will be achieved as a result of the implementation of IPK – forms of education included in Annexes 1-4

Symbol number effect	Assumed learning outcomes	*The learning effect will be achieved as a result of the implementation of subjects/practice/ other forms of education included in the IPK[14]*
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	
D_U09	*initiate a debate*	
D_U10	*participate in scientific discourse*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	
Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	
D_K02	*taking up challenges in the professional and public spheres, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations,*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	
D_K06	*fulfilling the social obligations of researchers and creators*	
D_K07	*initiating activities for the public interest*	
D_K08	*think and act in an entrepreneurial way*	
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
No. 05/SDR/2019 of 2 October 2019

on the determination of the template of the Individual Research Plan for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 4 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 13/RKR/2019 of 23 May 2019. on the granting of the Organisational Regulations of the Doctoral School of the Military University of Technology, in connection with § 13 section 1 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is hereby decided: as follows:

§ 1

1. A template of the Individual Research Plan for doctoral students of the Doctoral School of the Military University of Technology is hereby defined, which is attached to the decision.
2. The template referred to in paragraph 1 shall be valid from the academic year 2019/2020.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD Eng.

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 05/SDR/2019
of 2 October 2019

APPROVED Warsaw, dn.....

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL RESEARCH PLAN (IPB) No. .....[1]

1. Name and surname of the PhD student:
   .....
2. Scientific discipline: .....
3. Year of commencement of education at the Doctoral School:.....
4. Title/degree, name and surname of the supervisor(s):
   ……
   ……
5. Title/degree, name and surname of the assistant supervisor:
   ……
6. Planned topic of the doctoral dissertation:
   ……
   ……
   ……
   ……
   ……
7. Concept and scope of the doctoral dissertation – Appendix no. 1
8. Planned deadline for submission of the doctoral dissertation *(dd/mm/yyyy)*:
   .....

[1] In the case of changes to the IPB, a subsequent ordinal number is assigned; No. 1 concerns the first IPB

9. Planned date of obtaining a certificate certifying knowledge of the modern language at the level of language proficiency at least B2[2] *(dd/mm/yyyy)*: .....

[2] only in the case of doctoral students who do not have a certificate or diploma of graduation certifying knowledge of modern language at the level of language proficiency of at least B2

10. Deadline for meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science *(dd/mm/yy)*:.....
11. Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects - Appendix no. 2
12. Learning outcomes to be achieved as a result of the implementation of the Individual Research Plan – Appendix No. 3
13. Opinion of the assistant supervisor (optional) – Appendix No. 3.
14. Information on changes introduced in relation to the previous version of the IPB

……

……

……

Date and legible signature of the doctoral student

The Individual Research Plan has been prepared in consultation with the supervisor(s).

……

Date and legible signature of the supervisor(s)

Attachments

Appendix no. 1 – Concept and scope of the doctoral dissertation
Appendix no. 2 - Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects
Appendix 3 - Learning outcomes at level 8 of the Polish Qualifications Framework to be achieved as a result of the implementation of the Individual Research Plan
Appendix no. 4 - Opinion of the assistant supervisor (optional)

IPB filing date	Legible signature of an employee of the Doctoral School

Appendix No. 1
to the Individual Research Plan

Concept and scope of the doctoral dissertation

Appendix No. 2
to the Individual Research Plan

Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects

1. Elaboration of issues within the doctoral dissertation

Lp.	Stages of the doctoral thesis and the issues pursued*	Share in the total dissertation (%)	Semester(s)
1.			
2.			
3.			
4.			
5.			

* - the stages of work should take into account semester papers prepared by doctoral students from the third semester of education

2. Planned speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Comments
1.			
2.			
3.			
4.			
5.			

3. Planned participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Comments
1.			
2.			
3.			

4. Planned implementation of a research internship or study trip to a domestic or foreign university or scientific institution

Lp.	Type of trip	Name of the university or scientific institution	Place	Deadline - year
1.				
2.				
3.				

5. Planned publications (dissemination of R+D results on the basis of open access)

Lp.	Publisher	Deadline - year	List of the Ministry of Science and Higher Education (yes/NO)	Comments
1.				
2.				
3.				

Appendix No. 3
to the Individual Research Plan

Learning outcomes to be achieved as a result of the implementation of the Individual Research Plan (IPB)

Reference to the learning outcomes included in the Curriculum of the Doctoral School of the Jarosław Dąbrowski Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 36/WAT/2019 of 30 May 2019 on the establishment of the "Curriculum of the Doctoral School of the Jarosław Dąbrowski Military University of Technology"

Symbol number effect	Expected learning outcomes	code 8 PRK	CAREERS AT IPB YES/NO
	Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	*P8S_WG*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_WG*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*	
D_W03	*development trends in the scientific discipline*	*P8S_WG*	
D_W04	*methodology of scientific research*	*P8S_WG*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	*P8S_WG*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*	
	Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	*P8S_UK* *P8S_UU*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	*P8S_UW*	
D_U02	*create new elements of scientific and creative achievements*	*P8S_UW*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	*P8S_UW*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	*P8S_UW*	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	*P8S_UW*	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*	

Symbol number effect	Expected learning outcomes	code 8 PRK	CAREERS AT IPB YES/NO
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	*P8S_UK*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*	
D_U09	*initiate a debate*	*P8S_UK*	
D_U10	*participate in scientific discourse*	*P8S_UK*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	*P8S_UK*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	*P8S_UU*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	*P8S_UU*	
	Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	*P8U_KK*	
D_K02	*taking up challenges in the professional and public spheres, taking into account: – their ethical dimension, – responsibility for their consequences and shaping models of appropriate conduct in such situations,*	*P8U_KK*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8S_KK*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	*P8S_KK*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	*P8S_KK*	
D_K06	*fulfilling the social obligations of researchers and creators*	*P8S_KO*	
D_K07	*initiating activities for the public interest*	*P8S_KO*	
D_K08	*think and act in an entrepreneurial way*	*P8S_KO*	
D_K09	*maintaining and developing the ethos of research and creative environments, including: − conducting scientific activity in an independent manner, − respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8S_KR*	

Appendix No. 4
to the Individual Research Plan

Opinion of the assistant supervisor

……

……

……

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
No. 6/SDR/2021 of 8 April 2021

on the determination of the template of the Individual Research Plan for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School, constituting an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, in connection with § 13 section 1 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019 in on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. A template of an individual research plan for doctoral students of the Military University of Technology Doctoral School is hereby defined, constituting an annex to the decision, subject to paragraph 2.
2. Individual research plans developed by the date of entry into force of this decision on the basis of the decision referred to in § 3 shall not require adaptation to the template specified in paragraph 1.
3. The formula specified in paragraph 1 shall be applied to changes to the individual research plan referred to in paragraph 2.

§ 2

The decision enters into force on the day of signing.

§ 3

The decision of the Director of the Military University of Technology Doctoral School No. 05/SDR/2019 of 2 October 2019 on the determination of the template of the Individual Research Plan for doctoral students of the Jarosław Dąbrowski Military University of Technology Doctoral School is hereby repealed.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 6/SDR/2021
of 8 April 2021

APPROVED Warsaw, ...

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL RESEARCH PLAN (IPB) No. .....[1]
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL
OF THE MILITARY UNIVERSITY OF TECHNOLOGY

And. PhD student's data and information about supervisors

1. Name and surname of the PhD student, ORCID No

2. Scientific discipline

3. Academic year of commencement of education at the Doctoral School

4. Title/degree, name of the supervisor(s)

5. Degree, name of the assistant supervisor[2]

[1] in the case of making changes to the IPB, developing a new version, a subsequent ordinal number is assigned; No. 1 concerns the first IPB
[2] if it has been appointed

II. Information about the planned doctoral dissertation

1. Planned topic of the doctoral dissertation

2. Planned form of the doctoral dissertation[3]

3. Justification for taking up the subject matter

4. The concept and scope of the doctoral dissertation, including the aim and hypotheses of the research and the methodology adopted *(max. 10,000 characters without spaces)*

[3] A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, design, construction, technological, implementation or artistic work, as well as an independent and separate part of a collective work (*Article 187(3) of the Act of 20 July 2018 – Law on Higher Education and Science*)

5. Planned research outcomes, including significance for the development of a given field and scientific discipline and ways of disseminating them

6. Current state of knowledge in the field of the doctoral dissertation

7. Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects - Appendix no. 1
8. Literature constituting the basis of the doctoral dissertation (max. 20 items) - Appendix no. 2
9. Planned date of submission of the doctoral dissertation

dd mm yy

III. Additional information

1. Planned date of obtaining a certificate certifying knowledge of the modern language at the level of language proficiency at least B2[4]

dd mm yy

[4] only in the case of doctoral students who do not have a certificate or diploma of graduation certifying knowledge of modern language at the level of language proficiency of at least B2

2. The planned date of meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science[5]

dd mm yy

3. Learning outcomes to be achieved as a result of the implementation of an individual research plan - Appendix no. 3
4. Opinion of the assistant supervisor (if appointed) - Appendix no. 4
5. Information on changes introduced in relation to the previous version of the IPB

……

date and legible signature of the doctoral student

I accept this individual research plan

……

date and legible signature of the supervisor(s)

Attachments

1. **Appendix no. 1** - Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects
2. **Appendix no. 2** - Literature constituting the basis of the doctoral dissertation
3. **Appendix 3** - Learning outcomes at level 8 of the Polish Qualifications Framework to be achieved as a result of the implementation of an individual research plan
4. **Appendix 4** - Opinion of the assistant supervisor, including a reference to the role in the implementation of the individual research plan, indication of areas and types of support for the doctoral student *(only in the case of appointing an assistant supervisor to the doctoral student)*

[5] possession of at least:
a) 1 scientific article published in a scientific journal or in peer-reviewed materials from an international conference, which in the year of publication of the article in its final form were included in the list of the Ministry of Science and Higher Education (MEiN), or
b) 1 scientific monograph published by a publishing house that in the year of publication of the monograph in its final form was included in the list of the Ministry of Science and Higher Education (MEiN), or a chapter in such a monograph,

IPB filing date	Legible signature of an employee of the Doctoral School

Appendix No. 1
for an individual research plan

Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects

I. Preparation of the doctoral dissertation

1. Information on research issues carried out in the first and second semesters

Lp.	Preparatory issues completed (short, synthetic description)	Share in the total dissertation (%)
1.		

2. Elaboration of issues as part of the doctoral dissertation in semesters III-VIII[6]

Lp.	Stages of preparation of the doctoral dissenter, and the issues and research carried out (short, synthetic description)	Share in the whole of the hearing (%)	Implementation semester
1.			**III**
2.			**IV**
3.			**V**
4.			**VI**
5.			**VII**

[6] the implementation of the IPB for semester III and IV, i.e. for mid-term evaluation, should not be less than 35% of the total dissertation

6.			**VIII**

II. Scientific activity of a doctoral student[7]

1. Speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				

2. Participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				

3. Implementation of a research internship or study trip to a domestic or foreign university or scientific institution[8]

Lp.	Purpose and type of trip	Name of the university or scientific institution	Place	Departure date from-to
1.				

4. Publications[9]

Lp.	Author(s) of the publication and planned title[10]	Publisher and planned release date	List of Ministry of Science and Higher Education (yes/no)	Publication status[11]

[7] the scientific activity of a doctoral student covers the period from the date of commencement of education at the Doctoral School

[8] With the consent of the supervisor, the research internship may be carried out in another institution whose activity is related to the subject of the doctoral student's doctoral dissertation

[9] You should enter both publications that have already been published, accepted for printing, sent for review, and planned publications

[10] if it is possible to specify contributors

[11] Publication status: sent to the publishing house, accepted for review, accepted for printing, published

			number of points	
1.				

Appendix No. 2
for an individual research plan

Literature
constituting the basis of the doctoral dissertation

/max. 20 items in the author/authors, title, publisher name, place and year of publication, ISBN/

1.

2.

3.

.

.

.

20.

Appendix No. 3
for an individual research plan

Learning outcomes to be achieved as a result of the implementation of an individual research plan (IPI)

Reference to the learning outcomes included in the Curriculum at the Jarosław Dąbrowski Military University of Technology Doctoral School[12]

Symbol number effect	assumed learning outcomes included in the Curriculum at the Doctoral School	code 8 PRK	Reference to learning (YES/NO)		
			Common Items[13]	IPK[14]	CAREERS AT IPB
Knowledge: the graduate knows and understands					
D_W WAT01	*methods and techniques of conducting didactic classes.*	*P8S_WG*			
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	*P8U_WG*			
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	*P8S_WG*			
D_W03	*development trends in the scientific discipline*	*P8S_WG*			
D_W04	*methodology of scientific research*	*P8S_WG*			
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	*P8S_WG*			
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	*P8S_WK*			
Skills: the graduate can					
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	*P8S_UK P8S_UU*			
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	*P8S_UKP8S_UO*			
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research*	*P8S_UW*			

[12] applies to the curriculum in force from the academic year in which the doctoral student began his or her education

[13] enter the values from the table of learning outcomes for the subjects of the Basic Module (Chapter V. Modules of the curriculum) included in the curriculum in force from the academic year in which the doctoral student began his or her education

[14] the values from the table of learning outcomes included in Appendix 5 of the individual education programme should be entered

Symbol number effect	assumed learning outcomes included in the Curriculum at the Doctoral School	code 8 PRK	Reference to learning (YES/NO)		
			Common Items[13]	IPK[14]	CAREERS AT IPB
	problems and problems related to innovative and creative activities;				
D_U02	*create new elements of scientific and creative achievements*	*P8S_UW*			
D_U03	*independently plan their own development and inspire the development of others participate in the exchange of experiences and ideas, also in the international environment*	*P8S_UW*			
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: − define the purpose and subject of scientific research, formulate a research hypothesis, − develop research methods, techniques and tools and apply them creatively, − draw conclusions based on the results of scientific research*	*P8S_UW*			
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	*P8S_UW*			
D_U06	*transfer the results of scientific activity to the economic and social sphere*	*P8S_UW*			
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	*P8S_UK*			
D_U08	*disseminate the results of scientific activity, also in popular forms*	*P8S_UK*			
D_U09	*initiate a debate*	*P8S_UK*			
D_U10	*participate in scientific discourse*	*P8S_UK*			
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	*P8S_UK*			
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	*P8S_UO*			
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	*P8S_UU*			
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	*P8S_UU*			
Social competence: the graduate is ready to					
D_K01	*independent research that enhances the existing scientific and creative achievements*	*P8U_KK*			
D_K02	*taking up challenges in the professional and public spheres, taking into account: – their ethical dimension,*	*P8U_KK*			

Symbol number effect	assumed learning outcomes included in the Curriculum at the Doctoral School	code 8 PRK	Reference to learning (YES/NO)		
			Common Items[13]	IPK[14]	CAREERS AT IPB
	– responsibility for their consequences and shaping models of appropriate conduct in such situations,				
D_K03	*critical evaluation of achievements within a given scientific discipline*	*P8S_KK*			
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	*P8S_KK*			
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	*P8S_KK*			
D_K06	*fulfilling the social obligations of researchers and creators*	*P8S_KO*			
D_K07	*initiating activities for the public interest*	*P8S_KO*			
D_K08	*think and act in an entrepreneurial way*	*P8S_KO*			
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	*P8S_KR*			

Appendix No. 4
for an individual research plan

Opinion
assistant supervisor[15]

1. **Name and surname of the doctoral student**

2. **Degree, name of the assistant supervisor**

3. **Opinion on the individual research plan of the doctoral student along with the role of the assistant supervisor in its implementation**

……

Date and legible signature of the assistant supervisor

[15] if it has been appointed

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 7/SDR/2022 of 1 April 2022

on the determination of the template of the individual research plan for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 12(1) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 21/WAT/2021 of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. A template of an individual research plan for doctoral students of the Military University of Technology Doctoral School is hereby defined, constituting an annex to the decision, subject to paragraph 2.
2. Individual research plans developed by the date of entry into force of this decision on the basis of the decision referred to in § 3 shall not require adaptation to the template specified in paragraph 1.
3. The formula specified in paragraph 1 shall be applied to changes to the individual research plan referred to in paragraph 2.

§ 2

The decision of the Director of the Military University of Technology Doctoral School No. 6/SDR/2021 of 8 April 2021 on the determination of the template of the Individual Research Plan for doctoral students of the Jarosław Dąbrowski Military University of Technology Doctoral School is hereby repealed.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 7/SDR/2022
of 1 April 2022

APPROVED Warsaw, ...

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL RESEARCH PLAN (IPB) No. .....[1]
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL
OF THE UNIVERSITY OF TECHNOLOGY

And. Information data

1. Name and surname of the PhD student, ORCID No

2. Scientific discipline

3. Academic year of commencement of education at the Doctoral School

4. Title/degree, name of the supervisor(s)

5. Degree, name of the assistant supervisor[2]

[1] in the case of making changes to the IPB, developing a new version, a subsequent ordinal number is assigned; No. 1 concerns the first IPB
[2] if it has been appointed

II. Information about the doctoral dissertation

1. Planned topic of the doctoral dissertation

2. Planned form of the doctoral dissertation[3]

3. Justification for taking up the subject *matter (max. 4,000 characters without spaces)*

4. The concept and scope of the doctoral dissertation, including the aim and hypotheses of the research and the methodology adopted *(max. 10,000 characters without spaces)*

[3] A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, design, construction, technological, implementation or artistic work, as well as an independent and separate part of a collective work (*Article 187(3) of the Act of 20 July 2018 – Law on Higher Education and Science*)

5. Planned research outcomes, including significance for the development of a given field and scientific discipline and ways of disseminating them *(max. 2,000 characters without spaces)*

6. Current state of knowledge in the field of the doctoral dissertation *(max. 4,000 characters without spaces)*

7. Keywords related to the doctoral dissertation

8. Planned date of submission of the doctoral dissertation

dd mm yy

III. Information on the changes introduced in relation to the previous version of the IPB

Changes to point ...
Scope of changes –

Changes in Appendix No.
Scope of changes -

……
date and legible signature of the doctoral student

I accept an individual study plan[4]

……
date and legible signature of the supervisor(s)

Attachments

1. **Appendix no. 1** - Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects
2. **Appendix no. 2** - Literature constituting the basis of the doctoral dissertation
3. **Appendix 3** - Learning outcomes to be achieved as a result of the implementation of an individual research plan
4. **Appendix 4** - Opinion of the assistant supervisor, if appointed

IPB filing date	legible signature of an employee of the Doctoral School

[4] Each attachment must be initialled by the supervisor(s)

Appendix No. 1
to the individual research plan no. ...

Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects

I. Preparation of the doctoral dissertation

1. Information on research issues carried out in the first and second semesters

Lp.	Preparatory issues completed (short, synthetic description)	Share in the total dissertation (%)
1.		

2. Elaboration of issues as part of the doctoral dissertation in semesters III-VIII[5]

Lp.	Stages of preparation of the doctoral dissenter, and the issues and research carried out (short, synthetic description)	Share in the whole of the hearing (%)	Implementation semester
1.			**III**
2.			**IV[6]**
3.			**V**
4.			**VI**
5.			**VII**

[5] the degree of advancement of the preparation of the doctoral dissertation from the beginning of education at the Doctoral School to the fourth semester, i.e. to the mid-term evaluation, should not be less than 35% of the total dissertation

[6] implementation by the date of submission of the interim report, i.e. 1 June of the year of the assessment

6.			**VIII**

II. Scientific activity[7]

1. Publications[8]

Lp.	Author(s) and title[9]	Publisher	Publication status and planned release date[10]	The publication is on the list of the Ministry of Science and Higher Education /[11] (YES/NO) number of points
1.				
2.				
3.				

2. Speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				
3.				

3. Participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				

[7] the scientific activity of a doctoral student covers the period from the date of commencement of education at the Doctoral School

[8] the list must contain at least one publication meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science

[9] if it is possible to specify contributors

[10] Publication status: planned, prepared, sent to the publishing house, accepted for review, accepted for printing, published

[11] referred to in Article 267(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science

2.				
3.				

4. Implementation of a research internship or study trip to a domestic or foreign university or scientific institution[12]

Lp.	Purpose and type of trip	Name of the university or scientific institution	Place	Departure date from-to
1.				
2.				
3.				

5. Other scientific projects - implemented and planned to be implemented[13]

Lp.	Type of project	Deadline	Lead institution	% share	Comments
1.					
2.					
3.					

[12] With the consent of the supervisor, the research internship may be carried out in an institution other than the scientific one, whose activity is related to the subject of the doctoral student's doctoral dissertation

[13] participation of a PhD student in projects, grenades, programs, etc.

Appendix No. 2
to the individual research plan no. ...

Literature
constituting the basis of the doctoral dissertation[14]

/max. 20 items in the author/authors, title, publisher name, place and year of publication, ISBN/

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

[14] References to websites may also be indicated in the list of references

Appendix No. 3
to the individual research plan no. ...

Learning outcomes to be achieved as a result of the implementation of an individual research plan (IPI)

Assumed learning outcomes included in the Doctoral School Education Program[15]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	
D_W03	*development trends in the scientific discipline*	
D_W04	*methodology of scientific research*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	
Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	
D_U02	*create new elements of scientific and creative achievements*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	

[15] applies to the curriculum in force from the academic year in which the doctoral student began his or her education

Assumed learning outcomes included in the Doctoral School Education Program[15]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	
D_U09	*initiate a debate*	
D_U10	*participate in scientific discourse*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	
Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	
D_K02	*taking up challenges in the professional and public spheres, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations,*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	
D_K06	*fulfilling the social obligations of researchers and creators*	
D_K07	*initiating activities for the public interest*	
D_K08	*think and act in an entrepreneurial way*	
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	

Appendix No. 4
to the individual research plan no. ...

Opinion
assistant supervisor[16]

1. **Name and surname of the doctoral student**

2. **Degree, name of the assistant supervisor**

3. **Opinion on the individual research plan of the doctoral student along with the role of the assistant supervisor in its implementation**

……

date and legible signature of the assistant supervisor

[16] if it has been appointed

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No 3/SDR/2024 of 18 April 2024

on the determination of the template of the individual research plan for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 12 section 1 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to Resolution No. 62/WAT/2023 of 27 April 2023 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. A template of an individual research plan for doctoral students of the Military University of Technology Doctoral School is hereby defined, constituting an annex to the decision, subject to paragraph 2.
2. Individual research plans developed by the date of entry into force of this Decision on the basis of the decision referred to in § 2 shall not require adaptation to the model specified in paragraph 1.
3. The formula specified in paragraph 1 shall be applied to changes to the individual research plan referred to in paragraph 2.

§ 2

The decision of the Director of the Military University of Technology Doctoral School No. 7/SDR/2022 of 1 April 2022 on the determination of the template of the Individual Research Plan for doctoral students of the Military University of Technology Doctoral School is no longer in force.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

(--) Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. ..../SDR/2024
of 2024

APPROVED .....

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL RESEARCH PLAN (IPB) No. .....[1] DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE UNIVERSITY OF TECHNOLOGY

And. Information data

1. Name and surname of the PhD student, ORCID No

2. Scientific discipline

3. Academic year of commencement of education at the Doctoral School

4. Title/degree, name of the supervisor(s)

5. Degree, name of the assistant supervisor[2]

6. Degree, name and surname of the assistant supervisor[3]

[1] in the case of making changes to the IPB, developing a new version, a subsequent ordinal number is assigned; No. 1 concerns the first IPB
[2] if it has been appointed
[3] only for doctoral students pursuing education at the Doctoral School of the Military University of Technology as part of the program entitled "Implementation Doctorate"

II. Information about the doctoral dissertation

1. Planned topic of the doctoral dissertation

2. Planned form of the doctoral dissertation[4]

3. Justification for taking up the subject *matter (max. 4,000 characters without spaces)*

4. The concept and scope of the doctoral dissertation, including the aim and hypotheses of the research and the methodology adopted *(max. 10,000 characters without spaces)*

5. The subject of the doctoral dissertation – indicating aspects of originality and innovation in solving a scientific problem or in the application of the results of one's own scientific research in the economic or social sphere – *(max. 1,000 characters without spaces)*

6. Description of the significance of the planned research outcomes for the development of the field of science and scientific discipline and the ways of their dissemination *(max. 2,000 characters without spaces)*

7. Current state of knowledge in the field of the doctoral dissertation *(max. 4,000 characters without spaces)*

8. Keywords related to the doctoral dissertation

[4] A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, design, construction, technological, implementation or artistic work, as well as an independent and separate part of a collective work (*Article 187(3) of the Act of 20 July 2018 – Law on Higher Education and Science*)

9. Planned date of submission of the doctoral dissertation

dd mm yy

III. Information on the changes introduced in relation to the previous version of the IPB

Changes to point ...
Scope of changes –

Changes in Appendix No.
Scope of changes -

.....
date and legible signature of the doctoral student

I accept an individual study plan[5]

.....
date and legible signature of the supervisor(s)

Attachments

1. **Appendix no. 1** - Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects*
2. **Appendix no. 1a** - Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects of doctoral students submitting an application for extension of the deadline for submitting a doctoral dissertation*
3. **Appendix no. 2** - Literature constituting the basis of the doctoral dissertation
4. **Appendix 3** - Learning outcomes to be achieved as a result of the implementation of an individual research plan
5. **Appendix 4** - Opinion of the assistant supervisor, if appointed*
6. **Appendix no. 5** - Opinion of the assistant supervisor, if appointed (only for doctoral students - participants of the "Implementation Doctorate" program)*

IPB filing date	legible signature of an employee of the Doctoral School

[5] Each attachment must be initialled by the supervisor(s)

* delete unnecessary

Appendix No. 1
to the individual research plan no. ...

Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects

I. Preparation of the doctoral dissertation

1. Information on research issues carried out in the first and second semester

Lp.	Preparatory and research issues completed (short, synthetic description)	Share in the total dissertation (%)
1.		

2. Elaboration of issues as part of the doctoral dissertation in semesters III-VIII[6]

Lp.	Stages of preparation of the doctoral dissertation and planned issues, research, chapters of the dissertation (short, synthetic description or specification)	Planned participation in the whole of the hearing (%)	Implementation semester
1.			**III**
2.			**IV[7]**
3.			**V**
4.			**VI**

[6] the degree of advancement of the preparation of the doctoral dissertation from the beginning of education at the Doctoral School to the fourth semester, i.e. to the mid-term evaluation, should not **be less than 35% of the total dissertation**

[7] implementation by the deadline for submitting the interim report

Lp.	Stages of preparation of the doctoral dissertation and planned issues, research, chapters of the dissertation (short, synthetic description or specification)	Planned participation in the whole of the hearing (%)	Implementation semester
5.			VII
6.			VIII

II. Scientific activity[8]

1. Publishing activities[9]

Lp.	Author(s) and title[10]	Publisher	Publication status and planned release date (year)[11]	Number of points according to the Minister's lists[12]
1.				
2.				
3.				

2. Speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				

[8] the scientific activity of a doctoral student covers the period from the date of commencement of education at the Doctoral School

[9] the list must contain at least one publication meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science

[10] if it is possible to specify contributors

[11] Publication status: planned, prepared, sent to the publishing house, accepted for review, accepted for printing, published

[12] referred to in Article 267(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science

3.				

3. Participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				
3.				

4. Implementation of a research internship or study trip to a domestic or foreign university or scientific institution[13]

Lp.	Purpose and type of trip	Name of the university or scientific institution	Place	Departure date from-to
1.				
2.				
3.				

5. Other scientific projects - completed and planned to be implemented[14]

Lp.	Type of project	Deadline	Lead institution	% of project participation	Comments
1.					
2.					
3.					

[13] With the consent of the supervisor, the research internship may be carried out in an institution other than the scientific one, whose activity is related to the subject of the doctoral student's doctoral dissertation

[14] participation of a PhD student in projects, grenades, programs, etc.

Appendix No. 1a
to the individual research plan no. ...

Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects of doctoral students who have obtained consent to extend the deadline for submitting their doctoral dissertation

I. Preparation of the doctoral dissertation

1. Information on research issues carried out in the first and second semester

Lp.	Preparatory and research issues completed (short, synthetic description)	Share in the total dissertation (%)
1.		

2. Elaboration of issues within the doctoral dissertation from the third to the eighth semester of education

Lp.	Stages of preparation of the doctoral dissertation and planned issues, research, chapters of the dissertation (short, synthetic description or specification)	Share in the whole of the hearing (%)		Implementation semester
		Planned[15]	Realized[16]	
1.				III
2.				IV
3.				V

[15] indicate the planned share included in the IPB
[16] based on semester reports

Lp.	Stages of preparation of the doctoral dissertation and planned issues, research, chapters of the dissertation (short, synthetic description or specification)	Share in the whole of the hearing (%)		Implementation semester
		Planned[15]	Realized[16]	
4.				VI
5.				VII
6.				VIII
Status of preparation of the doctoral dissertation at the end of the nominal period of education (%)				

3. Elaboration of issues within the doctoral dissertation during the extension of the deadline for submitting the doctoral dissertation

Lp.	Stages of preparing a doctoral dissertation	Share in the whole of the hearing (%)		Implementation semester
		And extension	Second extension[17]	
1.				IX
2.				X
3.				XI
4.				XII

[17] in the case of the second extension in the semesters covering the first extension, the participation in the entire dissertation should be indicated

II. Scientific activity[18]

1. Publishing activities[19]

Lp.	Author(s) and title[20]	Publisher	Publication status and planned release date[21]	Number of points according to the Minister's lists[22]
1.				
2.				
3.				

2. Speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				
3.				

3. Participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				

[18] the scientific activity of a doctoral student covers the period from the date of commencement of education at the Doctoral School

[19] the list must contain at least one publication meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science

[20] if it is possible to specify contributors

[21] Publication status: planned, prepared, sent to the publishing house, accepted for review, accepted for printing, published

[22] referred to in Article 267(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science

2.				
3.				

4. Implementation of a research internship or study trip to a domestic or foreign university or scientific institution[23]

Lp.	Purpose and type of trip	Name of the university or scientific institution	Place	Departure date from-to
1.				
2.				
3.				

5. Other scientific projects - implemented and planned to be implemented[24]

Lp.	Type of project	Deadline	Lead institution	% share	Comments
1.					
2.					

[23] With the consent of the supervisor, the research internship may be carried out in an institution other than the scientific one, whose activity is related to the subject of the doctoral student's doctoral dissertation

[24] participation of a PhD student in projects, grenades, programs, etc.

Appendix No. 2
to the individual research plan no. ...

Literature
constituting the basis of the doctoral dissertation[25]

/max. 20 items in the author/authors, title, publisher name, place and year of publication, ISBN/

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

[25] References to websites may also be indicated in the list of references

Appendix No. 3
to the individual research plan no. ...

Learning outcomes to be achieved as a result of the implementation of an individual research plan (IPI)

Assumed learning outcomes included in the Doctoral School Education Program[26]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	
D_W03	*development trends in the scientific discipline*	
D_W04	*methodology of scientific research*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	
Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	
D_U02	*create new elements of scientific and creative achievements*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	

[26] applies to the curriculum in force from the academic year in which the doctoral student began his or her education

Assumed learning outcomes included in the Doctoral School Education Program[26]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	
D_U09	*initiate a debate*	
D_U10	*participate in scientific discourse*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	
Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	
D_K02	*taking up challenges in the professional and public spheres, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations,*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	
D_K06	*fulfilling the social obligations of researchers and creators*	
D_K07	*initiating activities for the public interest*	
D_K08	*think and act in an entrepreneurial way*	
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	

Appendix No. 4
to the individual research plan no. ...

Opinion
assistant supervisor[27]

1. **Name and surname of the doctoral student**

2. **Degree, name of the assistant supervisor**

3. **Opinion on the individual research plan of the doctoral student along with the role of the assistant supervisor in its implementation**

……
date and legible signature of the assistant supervisor

[27] if it has been appointed

Appendix No. 5
to the individual research plan no. ...

Opinion
Assistant Supervisor[28]

1. **Name and surname of the doctoral student**

2. **Name of the assistant supervisor**

3. **Opinion on the individual research plan of the doctoral student along with the role of the assistant supervisor in its implementation**

……
date and legible signature of the assistant supervisor

[28] only for doctoral students pursuing education at the Doctoral School of the Military University of Technology as part of the program entitled "Implementation Doctorate"
- the opinion, if possible, should be printed on the letterhead of the entity employing the doctoral student and the assistant supervisor

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No 10/SDR/2025 of 9 May 2025

on the determination of the template of the Individual Research Plan for doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 12 section 1 of the Regulations of the Doctoral School of the Military University of Technology, which is an annex to Resolution No. 28/WAT/2024 of 25 April 2024 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. A template of the Individual Research Plan for doctoral students of the WAT Doctoral School, constituting Annex No. 1 to the decision, subject to paragraph 2, is hereby defined.
2. For doctoral students of the WAT Doctoral School submitting an application for an extension of the deadline for submitting a doctoral dissertation, the template of the Individual Research Plan is specified in Appendix No. 2 to the decision.
3. Individual Research Plans developed by the date of entry into force of this Decision on the basis of the decision referred to in § 2 shall not require adaptation to the template specified in paragraph 1.
4. The template specified in paragraph 1 shall apply to amendments to the Individual Research Plan referred to in paragraph 3.

§ 2

The decision of the Director of the Military University of Technology Doctoral School No. 3/SDR/2024 of 18 April 2024 on the determination of the template of the Individual Research Plan for doctoral students of the Military University of Technology Doctoral School is hereby repealed.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 10/SDR/2025
of 9 May 2025

APPROVED .....

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL RESEARCH PLAN (IPB) No. .....[1] DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE UNIVERSITY OF TECHNOLOGY

And. Information data

1. Name and surname of the PhD student, ORCID No

2. Scientific discipline

3. Academic year of commencement of education at the Doctoral School

4. Title/degree, name of the supervisor(s)

5. Degree, name and surname of the assistant supervisor[2] /assistant supervisor[3]

[1] in the case of making changes to the IPB, developing a new version, a subsequent ordinal number is assigned; No. 1 concerns the first IPB
[2] if it has been appointed
[3] only for doctoral students pursuing education at the Doctoral School of the Military University of Technology as part of the program entitled "Implementation Doctorate"

II. Information about the doctoral dissertation

1. Planned topic of the doctoral dissertation

2. Planned form of the doctoral dissertation[4]

3. Justification for taking up the subject *matter (max. 3,000 characters without spaces)*

4. The concept and scope of the doctoral dissertation, including the aim and hypotheses of the research and the methodology adopted *(max. 5,000 characters without spaces)*

5. The subject of the doctoral dissertation – indicating aspects of originality and innovation in solving a scientific problem or in the application of the results of one's own scientific research in the economic or social sphere – *(max. 1,000 characters without spaces)*

6. Description of the significance of the planned research outcomes for the development of the field of science and scientific discipline and the ways of their dissemination *(max. 2,000 characters without spaces)*

7. Current state of knowledge in the field of the doctoral dissertation *(max. 3,000 characters without spaces)*

8. Keywords related to the subject of the doctoral dissertation (max. 7 words)

[4] A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, design, construction, technological, implementation or artistic work, as well as an independent and separate part of a collective work (*Article 187(3) of the Act of 20 July 2018 – Law on Higher Education and Science*)

9. Planned date of submission of the doctoral dissertation

dd mm yy

III. Information on the changes introduced in relation to the previous version of the IPB

Changes to point ...
Scope of changes –

Changes in Appendix No.
Scope of changes -

.....
date and legible signature of the doctoral student

I accept the Individual Research Plan (IPB)[5]

.....
date and legible signature of the supervisor(s)

Attachments

1. **Appendix no. 1** - Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects
2. **Appendix no. 2** - Literature constituting the basis of the doctoral dissertation
3. **Appendix 3** - Learning outcomes to be achieved as a result of the implementation of the Individual Research Plan
4. **Appendix 4** - Opinion of the assistant supervisor, if appointed*
5. **Appendix no. 5** - Opinion of the assistant supervisor, if appointed (only for doctoral students - participants of the "Implementation Doctorate" program*

IPB filing date	legible signature of an employee of the Doctoral School

[5] Each attachment must be initialled by the supervisor(s)

* delete unnecessary

Appendix No. 1
to the Individual Research Plan No. ...

Detailed schedule for the preparation of the doctoral dissertation and the implementation of scientific projects

I. Preparation of the doctoral dissertation

1. Information on research issues carried out in the first and second semester

Lp.	Preparatory and research issues completed *(short, synthetic description – max. 1000 characters without spaces)*	Share in the total dissertation (%)
1.		

2. Elaboration of issues as part of the doctoral dissertation in semesters III-VIII[6]

Lp.	Stages of preparation of the doctoral dissertation and planned issues, research, chapters of the dissertation *(short, synthetic description – max. 300 characters without spaces for one line)*	Planned participation in the whole of the hearing (%)	Implementation semester
1.			**III**
2.			**IV[7]**
3.			**V**
4.			**VI**

[6] the degree of advancement of the preparation of the doctoral dissertation from the beginning of education at the Doctoral School to the fourth semester, i.e. to the mid-term evaluation, should not **be less than 35% of the total dissertation**

[7] implementation by the deadline for submitting the interim report

Lp.	Stages of preparation of the doctoral dissertation and planned issues, research, chapters of the dissertation *(short, synthetic description – max. 300 characters without spaces for one line)*	Planned participation in the whole of the hearing (%)	Implementation semester
5.			**VII**
6.			**VIII**

II. Scientific activity[8]

1. Publishing activities[9]

Lp.	Author(s) and title[10]	Publisher	Publication status and planned release date (year)[11]	Number of points according to the Minister's lists[12]
1.				
2.				
3.				

2. Speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				

[8] the scientific activity of a doctoral student covers the period from the date of commencement of education at the Doctoral School

[9] the list must contain at least one publication meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science

[10] if it is possible to specify contributors

[11] Publication status: planned, prepared, sent to the publishing house, accepted for review, accepted for printing, published

[12] referred to in Article 267(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science

3.				

3. Participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				
3.				

4. Implementation of a research internship or study trip to a domestic or foreign university or scientific institution[13]

Lp.	Purpose and type of trip	Name of the university or scientific institution	Place	Departure date from-to
1.				
2.				
3.				

5. Other scientific projects - completed and planned to be implemented[14]

Lp.	Type of project	Deadline	Lead institution	% of project participation	Comments
1.					
2.					
3.					

[13] With the consent of the supervisor, the research internship may be carried out in an institution other than the scientific one, whose activity is related to the subject of the doctoral student's doctoral dissertation

[14] participation of a PhD student in projects, grenades, programs, etc.

Appendix No. 2
to the Individual Research Plan No. ...

Literature
constituting the basis of the doctoral dissertation[15]

/max. 20 items in the author/authors, title, publisher name, place and year of publication, ISBN/

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

[15] References to websites may also be indicated in the list of references

Appendix No. 3
to the Individual Research Plan No. ...

Learning outcomes to be achieved as a result of the implementation of the Individual Research Plan (IPB)

Assumed learning outcomes included in the Doctoral School Education Program[16]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	
D_W03	*development trends in the scientific discipline*	
D_W04	*methodology of scientific research*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	
Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	
D_U02	*create new elements of scientific and creative achievements*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	

[16] applies to the curriculum in force from the academic year in which the doctoral student began his or her education

Assumed learning outcomes included in the Doctoral School Education Program[16]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	
D_U09	*initiate a debate*	
D_U10	*participate in scientific discourse*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	
Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	
D_K02	*taking up challenges in the professional and public spheres, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations,*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	
D_K06	*fulfilling the social obligations of researchers and creators*	
D_K07	*initiating activities for the public interest*	
D_K08	*think and act in an entrepreneurial way*	
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	

Appendix No. 4
to the Individual Research Plan No. ...

Wojskowa Akademia Techniczna

Szkoła Doktorska SDR

Opinion
assistant supervisor[17]

1. **Name and surname of the doctoral student**

2. **Degree, name of the assistant supervisor**

3. **Opinion on the Individual Research Plan of the PhD student with the role of the assistant supervisor in its implementation**

.....
date and legible signature of the assistant supervisor

[17] if it has been appointed

Appendix No. 5
to the Individual Research Plan No. ...

Opinion
assistant supervisor of a doctoral student pursuing education at the Doctoral School of the Military University of Technology as part of the "Implementation Doctorate" program

1. **Name and surname of the doctoral student**

2. **Name of the assistant supervisor**

3. **Opinion on the Individual Research Plan of the PhD student along with the role of the assistant supervisor in its implementation**

……
date and legible signature of the assistant supervisor

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 10/SDR/2025
of 9 May 2025

I APPROVE .....Dn.....

……..……..
(name stamp and signature of the Director of the Doctoral School)

INDIVIDUAL RESEARCH PLAN (IPB) No. .....[18]
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE UNIVERSITY OF TECHNOLOGY

DURING THE EXTENSION PERIOD
SUBMISSION OF A DOCTORAL DISSERTATION

And. Information data

1. Name and surname of the PhD student, ORCID No

2. Scientific discipline

3. Academic year of commencement of education at the Doctoral School

4. Title/degree, name of the supervisor(s)

5. Degree, name and surname of the assistant supervisor[19] /assistant supervisor[20]

[18] IPB Order Number
[19] if it has been appointed
[20] only for doctoral students pursuing education at the Doctoral School of the Military University of Technology as part of the program entitled "Implementation Doctorate"

II. Information about the doctoral dissertation

1. Planned topic of the doctoral dissertation

2. Planned form of the doctoral dissertation[21]

3. Keywords related to the subject of the doctoral dissertation (max 7 words)

4. The subject of the doctoral dissertation – indicating aspects of originality and innovation in solving a scientific problem or in the application of the results of one's own scientific research in the economic or social sphere – *(max. 1,000 characters without spaces)*

5. Current state of preparation of the doctoral dissertation - *completed stages, description of the implementation and results (max. 5,000 characters without spaces)*

6. Degree of preparation of the doctoral dissertation – total dissertation

	%

[21] A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, design, construction, technological, implementation or artistic work, as well as an independent and separate part of a collective work (*Article 187(3) of the Act of 20 July 2018 – Law on Higher Education and Science*)

7. Issues to be completed during the extension period of the deadline for submitting the doctoral dissertation *(max. 1,000 characters without spaces)*

1. 2.

3. Planned date of submission of the doctoral dissertation:
    1. in accordance with the curriculum

dd mm yy

    2. And extension[22]

dd mm yy

    3. Second extension

dd mm yy

III. Information on the changes introduced in relation to the <u>first version of the IPB (in points)</u>

1. 2.

.....

date and legible signature of the doctoral student

I accept an individual research plan[23]

.....

date and legible signature of the supervisor(s)

[22] no later than 12 months from the date of submission of the doctoral dissertation in accordance with the curriculum (point 8(1))

[23] Each attachment must be initialled by the supervisor(s)

* delete unnecessary

Attachments

1. **Appendix no. 1** - Detailed schedule for the preparation of the doctoral dissertation during the period of extension of the deadline for submitting the doctoral dissertation
2. **Appendix no. 2 -** Scientific activity of the doctoral student
3. **Appendix no. 3** - Literature constituting the basis of the prepared doctoral dissertation
4. **Appendix 4** - Learning outcomes to be achieved as a result of the implementation of the Individual Research Plan
5. **Appendix 5** - Opinion of the assistant supervisor, if appointed*
6. **Appendix no. 6** - Opinion of the assistant supervisor, if appointed (only for doctoral students - participants of the program entitled "Implementation Doctorate*

IPB filing date	legible signature of an employee of the Doctoral School

Appendix No. 1
to the Individual Research Plan No. ...

Detailed schedule for the preparation of the doctoral dissertation during the period of extension of the deadline for submitting a doctoral dissertation

1. Elaboration of issues within the doctoral dissertation during the extension of the deadline for submitting the doctoral dissertation

Lp.	Planned issues *(short, synthetic description – max. 300 characters without spaces for one line)*	Share in the whole of the hearing (%)		Implementation semester
		And extension	Second extension[24]	
1.				IX
2.				X
3.				XI
4.				XII

[24] in the case of the second extension in the semesters covering the first extension, the participation in the entire dissertation should be indicated,

Appendix No. 2
to the Individual Research Plan No. ...

Scientific activity of a doctoral student[25]

1. Publishing activities[26]

Lp.	Author(s) and title[27]	Publisher	Publication status and planned release date[28]	Number of points according to the Minister's lists[29]
1.				
2.				

2. Speeches at national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				

3. Participation in the organization of national or international scientific conferences

Lp.	Conference name	Organization date -year	Form of the conference	Comments
1.				
2.				

[25] the scientific activity of a doctoral student covers the period from the date of commencement of education at the Doctoral School
[26] the list must contain at least one publication meeting the requirements set out in Article 186(1)(3) of the Act of 20 July 2018 – Law on Higher Education and Science
[27] if it is possible to specify contributors
[28] Publication status: planned, prepared, sent to the publishing house, accepted for review, accepted for printing, published
[29] referred to in Article 267(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science

4. Implementation of a research internship or study trip to a domestic or foreign university or scientific institution[30]

Lp.	Purpose and type of trip	Name of the university or scientific institution	Place	Departure date from-to
1.				
2.				
3.				

5. Other scientific projects - implemented and planned to be implemented[31]

Lp.	Type of project	Deadline	Lead institution	% share	Comments
1.					
2.					

[30] With the consent of the supervisor, the research internship may be carried out in an institution other than the scientific one, whose activity is related to the subject of the doctoral student's doctoral dissertation

[31] participation of a PhD student in projects, grenades, programs, etc.

Appendix No. 3
to the Individual Research Plan No. ...

Literature
constituting the basis of the doctoral dissertation[32]

/max. 20 items in the author/authors, title, publisher name, place and year of publication, ISBN/

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

[32] References to websites may also be indicated in the list of references

Appendix No. 4
to the individual research plan no. ...

Learning outcomes to be achieved as a result of the implementation of the Individual Research Plan (IPB)

Assumed learning outcomes included in the Doctoral School Education Program[33]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
Knowledge: the graduate knows and understands		
D_W WAT01	*methods and techniques of conducting didactic classes.*	
D_W01	*the world's scientific and technological achievements in a given scientific discipline and the resulting implications for practice*	
D_W02	*global scientific and technological achievements including theoretical foundations and general issues and selected specific issues – specific to a given scientific discipline*	
D_W03	*development trends in the scientific discipline*	
D_W04	*methodology of scientific research*	
D_W05	*principles for disseminating the results of scientific activity, including in the open access mode*	
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*	
Skills: the graduate can		
D_U WAT01	*prepare and conduct didactic classes related to the scientific discipline in a modern way*	
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*	
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovative and creative activities;*	
D_U02	*create new elements of scientific and creative achievements*	
D_U03	*independently plan their own development and inspire the development of others* *participate in the exchange of experiences and ideas, also in the international environment*	
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:* *− define the purpose and subject of scientific research, formulate a research hypothesis,* *− develop research methods, techniques and tools and apply them creatively,* *− draw conclusions based on the results of scientific research*	
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge;*	

[33] applies to the curriculum in force from the academic year in which the doctoral student began his or her education

Assumed learning outcomes included in the Doctoral School Education Program[33]		Will the learning outcome be achieved as a result of the IPB (YES/NO)
Symbol number effect	**Description of the learning effect**	
D_U06	*transfer the results of scientific activity to the economic and social sphere*	
D_U07	*communicate on specialist topics to the extent that enables active participation in the national and international scientific community*	
D_U08	*disseminate the results of scientific activity, also in popular forms*	
D_U09	*initiate a debate*	
D_U10	*participate in scientific discourse*	
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to the extent that enables participation in an international scientific and professional environment*	
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*	
D_U13	*independently plan and act for their own development and inspire and organize the development of others*	
D_U14	*plan classes or groups of classes and implement them using modern methods and tools*	
Social competence: the graduate is ready to		
D_K01	*independent research that enhances the existing scientific and creative achievements*	
D_K02	*taking up challenges in the professional and public spheres, taking into account:* *– their ethical dimension,* *– responsibility for their consequences and shaping models of appropriate conduct in such situations,*	
D_K03	*critical evaluation of achievements within a given scientific discipline*	
D_K04	*critical assessment of one's own contribution to the development of a given scientific discipline*	
D_K05	*recognising the importance of knowledge in solving cognitive and practical problems*	
D_K06	*fulfilling the social obligations of researchers and creators*	
D_K07	*initiating activities for the public interest*	
D_K08	*think and act in an entrepreneurial way*	
D_K09	*maintaining and developing the ethos of research and creative environments, including:* *− conducting scientific activity in an independent manner,* *− respect the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*	

Appendix No. 5
to the Individual Research Plan No. ...

Opinion
assistant supervisor[34]

1. **Name and surname of the doctoral student**

2. **Degree, name of the assistant supervisor**

3. **Opinion on the Individual Research Plan of the PhD student together with the definition of the role of the assistant supervisor in its implementation, taking into account the period of extension of the deadline for submitting the doctoral dissertation**

……

date and legible signature of the assistant supervisor

[34] if it has been appointed

Appendix No. 6
to the Individual Research Plan No. ...

Opinion
assistant supervisor of a doctoral student pursuing education at the Doctoral School of the Military University of Technology as part of the "Implementation Doctorate" program

1. **Name and surname of the doctoral student**

2. **Name of the assistant supervisor**

3. **Opinion on the Individual Research Plan of the PhD student together with the definition of the role of the assistant supervisor in its implementation, taking into account the period of extension of the deadline for submitting the doctoral dissertation**

……

date and legible signature of the assistant supervisor

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No 03/SDR/2019 of 24 September 2019

on the introduction of a template for the Subject Information Card at the Doctoral School of the Military University of Technology

Pursuant to § 6 section 4 point 11 of the Organisational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 13/RKR/2019 of 23 May 2019 on the granting of the Organisational Regulations of the Doctoral School of the Military University of Technology, it is decided as follows:

§ 1

1. A template of the Item Information Sheet, which is attached to the decision, is introduced.
2. The template referred to in paragraph 1 has been in force since the academic year 2019/2020 for subjects included in the Curriculum of the Doctoral School of the Military University of Technology, which is an annex to the Resolution of the Senate of the Military University of Technology No. 36/WAT/2019 of 30 May 2019 on the establishment of the "Curriculum of Training at the Doctoral School of the Military University of Technology".

§ 2

1. The Course Information Sheet (KIP) is prepared by the person teaching the course and submitted to the Dean's Office of the Doctoral School of the Military University of Technology at least two months before the start of the course, subject to paragraph 2.
2. The KIP requires approval by the Director of the Doctoral School of the Military University of Technology.
3. The KIP cannot be changed during the course of the course.
4. The person conducting the course is obliged to systematically analyze the content contained in the KIP and make any changes.
5. Any changes to the KIP are carried out taking into account the provisions of paragraphs 1-3.

§ 3

The decision enters into force on 1 October 2019.

Director
Doctoral School

(--) Piotr ZALEWSKI, PhD

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 03/SDR/2019
of 24 September 2019

"Accepted"
Director
Doctoral School

Piotr ZALEWSKI, PhD

ITEM INFORMATION SHEET

Item Name	***Course* name *in English***	***Item* name *in English***
Item code		
Language of instruction		
Module	*Compulsory/Optional**	
Scientific discipline		
Valid from the academic year		
Forms of classes, number of hours/ total number of hours		
Method of passing the course		
Number of ECTS credits		
Semester(s)		
Short description of the item	*a brief description of* the content of the subject *at a general level*	
Full course description (program content)	Lectures 1. *Topics of the next classes / number of hours / short description of the content of the classes* …… Exercise 1. *Topics of the next classes / number of hours / short description of the content of the classes* ……. Seminars 1. *Topics of the next classes / number of hours / short description of the content of the classes* …….	

Literature	Basic: *author, title, publisher, year of publication* …… Supplementary: *author, title, publisher, year of publication* ……
Reference to the learning outcomes included in the Curriculum	*Symbol and number of the learning effect*
Assessment methods and criteria (a method of verifying the achievement of the expected learning outcomes by the doctoral student)	The course is credited on the basis of: Achieving the effect:
Course Entry Requirements	
Additional information	
WAT organizational unit responsible for the subject	
Author of the item information sheet	
Date of creation of the card and author's signature	

* - *delete unnecessary*

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
Jarosław Dąbrowski

No 3/SDR/2023 of 9 March 2023

on the determination of the template for the list of learning outcomes expected to be achieved by a doctoral student as a result of the implementation of the education process at the Doctoral School of the Military University of Technology

Pursuant to § 103 sec. 6 point 11 of the Statute of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 5 sec. 6 of the Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the resolution No. 21/WAT/2021 of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology", the following is resolved:

§ 1

1. A template for the list of learning outcomes to be achieved by a doctoral student as a result of the implementation of the MUT Doctoral School's education process, hereinafter referred to as *the "List",* is defined, constituting an appendix to the decision.
2. The first summary of learning outcomes is prepared by the doctoral student and submitted to the dean's office of the doctoral school together with the first individual research plan.
3. In the event of changes to the individual curriculum or individual research plan, the doctoral student is obliged to update the list and submit it to the dean's office of the doctoral school together with the next version of the individual curriculum or individual research plan.

§ 2

The Decision of the Director of the Doctoral School of the Jarosław Dąbrowski Military University of Technology No. 10/SDR/2022 of 1 April 2022 on the determination of the template for the list of learning outcomes expected to be achieved by a doctoral student as a result of the education process at the Doctoral School of the Jarosław Dąbrowski Military University of Technology is repealed

§ 2

The decision shall enter into force on the date of signing.

Manager
Doctoral School of the Military
University of Technology

Piotr ZALEWSKI, PhD, Eng.,
Associate Professor

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the Decision
of the Director of the Doctoral School of the Military University of Technology No. .3/SDR/2023
of 9 March 2023

APPROVE Warsaw, ...

……..……..
(name stamp and signature of the Doctoral School Director)

Summary of learning outcomes assumed to be achieved by a doctoral student as a result of the implementation of the educational process of the Doctoral School of MUT

no.....

1. Name and surname of the doctoral student

2. Scientific discipline

3. Academic year of commencement of education at the Doctoral School

4. Documents constituting the basis for completing the matrix of learning outcomes

Document name	Current document number
1. Curriculum of the Doctoral School[1]	
2. Individualized Education Program (IPK)	
3.Individual Research Plan (IPB)	

[1] applies to the curriculum according to which the subjects of the basic module were carried out – enter the number of the resolution of the Senate of MUT establishing this program, e.g. for doctoral students starting their education from the academic year 2020/2021 – Resolution of the Senate of MUT No. 124/WAT/2020 of 27 February 2020.

5. Table of learning outcomes assumed to be achieved by a doctoral student as a result of the education process at the Doctoral School of MUT

Assumed learning outcomes included in the Doctoral School Curriculum		Will the learning outcome be achieved as a result of the implementation of the indicated element of the education process? /if YES then you should insert the character X/		
Effect symbol and number	**Description of the learning outcome**	**Implementation of the subjects of the basic module[2]**	**Implementation of an individualized learning program (IPK)[3]**	**Implementation of the Individual Research Plan (IPB)[4]**
Knowledge: the graduate knows and understands				
D_W WAT01	*methods and techniques of conducting classes.*			
D_W01	*the global scientific and technological achievements in a given scientific discipline and the resulting implications for practice*			
D_W02	*global scientific and technological achievements including theoretical foundations as well as general issues and selected specific issues – specific to a given scientific discipline*			
D_W03	*development trends in the scientific discipline*			
D_W04	*research methodology*			
D_W05	*rules for the dissemination of the results of scientific activity, also in the open access mode*			
D_W06	*fundamental dilemmas of modern civilization; economic, legal, ethical and other important determinants of scientific activity; basic principles of knowledge transfer to the economic and social sphere and commercialization of the results of scientific activity and know-how related to these results*			

[2] enter the values from the table of learning outcomes for the subjects of the Basic Module (Chapter V. Modules of the curriculum) included in the curriculum in force from the academic year in which the doctoral student began education

[3] the values from the table of learning outcomes included in Appendix 5 of the current individual doctoral education programme should be entered

[4] the values from the table of learning outcomes included in Appendix 3 of the current individual research plan of the doctoral student should be entered

Assumed learning outcomes included in the Doctoral School Curriculum		Will the learning outcome be achieved as a result of the implementation of the indicated element of the education process? /if YES then you should insert the character X/		
Effect symbol and number	**Description of the learning outcome**	**Implementation of the subjects of the basic module[2]**	**Implementation of an individualized learning program (IPK)[3]**	**Implementation of the Individual Research Plan (IPB)[4]**
Skills: the graduate is able to				
D_U WAT01	*prepare and conduct classes related to the scientific discipline in a modern way*			
D_U WAT02	*obtain the necessary information related to the conducted research, using sources, including English-language*			
D_U01	*analyse and creatively synthesize scientific and creative achievements in order to identify and solve research problems and problems related to innovation and creative activities;*			
D_U02	*create new elements of scientific and creative achievements*			
D_U03	*independently plan their own development and inspire the development of others participate in the exchange of experiences and ideas, also in the international environment*			
D_U04	*use knowledge to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: define the purpose and object of scientific research, formulate a research hypothesis, develop research methods, techniques and tools and creatively apply them, draw conclusions based on the results of scientific research*			
D_U05	*critically analyse and evaluate the results of scientific research, expert activity and other creative work and their contribution to the development of knowledge*			
D_U06	*transfer the results of scientific activity to the economic and social sphere*			
D_U07	*communicate on specialist topics to the extent that allows active participation in the national and international scientific community*			
D_U08	*disseminate the results of scientific activity, also in popular forms*			
D_U09	*initiate debate*			
D_U10	*participate in scientific discourse*			

Assumed learning outcomes included in the Doctoral School Curriculum		Will the learning outcome be achieved as a result of the implementation of the indicated element of the education process? /if YES then you should insert the character X/		
Effect symbol and number	**Description of the learning outcome**	**Implementation of the subjects of the basic module[2]**	**Implementation of an individualized learning program (IPK)[3]**	**Implementation of the Individual Research Plan (IPB)[4]**
D_U11	*use a foreign language at the B2 level of the Common European Framework of Reference for Languages to a degree that allows participation in the international scientific and professional environment;*			
D_U12	*plan and implement individual and team research or creative projects, also in an international environment*			
D_U13	*independently plan and act for their own development and inspire and organize the development of others*			
D_U14	*plan classes or groups of classes and carry them out using modern methods and tools*			
Social competences: the graduate is ready to				
D_K01	*independent research to increase existing scientific and creative output*			
D_K02	*taking up challenges in the professional and public sphere, taking into account their ethical dimension, responsibility for their consequences and shaping models of appropriate conduct in such situations*			
D_K03	*critical evaluation of achievements within a given scientific discipline*			
D_K04	*critically evaluate one's own contribution to the development of a given scientific discipline*			
D_K05	*recognition of the importance of knowledge in solving cognitive and practical problems*			
D_K06	*fulfilling the social obligations of researchers and creators*			
D_K07	*initiating activities in the public interest*			
D_K08	*thinking and acting in an entrepreneurial way*			

Assumed learning outcomes included in the Doctoral School Curriculum		Will the learning outcome be achieved as a result of the implementation of the indicated element of the education process? /if YES then you should insert the character X/		
Effect symbol and number	**Description of the learning outcome**	**Implementation of the subjects of the basic module[2]**	**Implementation of an individualized learning program (IPK)[3]**	**Implementation of the Individual Research Plan (IPB)[4]**
D_K09	*maintaining and developing the ethos of research and creative communities, including: conducting scientific activity in an independent manner, respecting the principle of public ownership of the results of scientific activity, taking into account the principles of intellectual property protection*			

6. Learning outcomes other than those mentioned in point 5 achieved by the doctoral student during education at the Doctoral School of MUT

Lp.	Description of the learning outcome
1.	
2.	

.....
date and legible signature of the doctoral student

Date of submission	legible signature of the Doctoral School employee

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 3/SDR/2020 of 19 November 2020

on the introduction of templates of documents related to the implementation of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 4 point 11 of the Organisational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organisational Regulations of the Doctoral School of the Military University of Technology, it is decided as follows:

§ 1

The following templates of documents related to the implementation of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology are introduced

1. Application for the implementation of the internship and appointment of the head of the internship, constituting Annex No. 1 to the decision
2. Report on the implementation of professional practice at the Military University of Technology, constituting Appendix No. 2 to the decision.
3. Report on the implementation of another form of education. constituting Annex No. 3 to the decision.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof.
WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 3/SDR/2020
of 19 November 2020

....., on .....

……
name and surname of the doctoral student

……..
discipline

……..
Email address

……..

……..
(Dean, Director)

REQUEST

In accordance with the provisions of the Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology, I would like to ask you to enable the implementation of the

……
Organizational unit name

professional practice in the form of conducting classes or participating in their conduct and appointing a practice manager.

Below I present the plan of professional practice resulting from the Individual Education Program approved by the Director of the Doctoral School of the Military University of Technology.

Lp.	**Academic year**	**Semester**	**Number of hours of professional practice in the form of:**		**Total number of hours in an academic year** ***(max. 60 hours)***
			conducting didactic classes by a doctoral student	**participation of the doctoral student in teaching**	
1		**winter**			
2		**lukewarm**			
3		**winter**			
4		**lukewarm**			
5		**winter**			
6		**lukewarm**			
Together					

……
PhD student's signature

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 3/SDR/2020
of 19 November 2020

.....Dn.....

REPORT

FROM THE IMPLEMENTATION OF THE INTERNSHIP AT THE UNIVERSITY OF TECHNOLOGY

in the academic year ...../.....

1. Name and surname of the doctoral student: .....
2. Scientific discipline: .....
3. Year of education: .....
4. Place of implementation (organizational unit): .....
5. Degree/title, name and surname of the head of the practice[1]:

   .....
6. As part of the internship, a total of ..... was completed in the academic year hours, including in the form of:

a) conducting didactic classes by a doctoral student

Lp.	Item Name	Form of classes (w/qw./lab/sem.)	Form of education (I/II/JSM/Course)	Number of hours	Semester (winter/summer)	Comments
1.						
2.						
3.						
4.						
5.						
A total of hours.						

b) participation of the doctoral student in conducting classes[2]

Lp.	Description of the activity (m.in. name of the course, lecturer of the course, role of the doctoral student, etc.)	Number of hours	Semester (winter/summer)	Comments
1.				
2.				
3.				
4.				
5.				
A total of hours.				

[1] in accordance with the Regulations of the WAT Doctoral School, the head of the organizational unit in which the doctoral student will carry out professional practice appoints a manager responsible for the implementation of professional practice by the doctoral student in the form of conducting classes or participating in conducting classes

[2] Participation in conducting classes is understood as m.in: participation in classes as an observer, assistance to an academic teacher in conducting classes, preparation of a laboratory station or development of instructions for exercises

……
Date and signature of the doctoral student

7. Manager's opinion:

.....

.....

.....

.....

.....

.....

.....

8. Evaluation of the internship (incl./nzal) .....

……
Date and signature of the practice manager

Note from the Dean's Office of the Doctoral School:

Received on .....

……..
date, signature of the dean's office employee

Appendix No. 3 to the Decision
Director of the Doctoral School of the Military University of Technology No. 3/SDR/2020
of 19 November 2020

.....Dn.....

REPORT

FROM THE IMPLEMENTATION OF[3] .....

in the academic year ...../.....

1. Name and surname of the doctoral student: .....
2. Scientific discipline: .....
3. Year of education: .....
4. Place of implementation (university/institution, faculty – city, country): .....

   .....

   .....
5. Degree/title of science, name and surname of the tutor[4]:

   .....
6. Total hours .....
7. Detailed scope of implementation *(description of activities – goal, tasks, duration, leader, achieved effects, etc.)*

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

   .....

[3] name of another form of education provided in and outside the Military University of Technology, in another national or foreign higher education institution or scientific institution: internship, practice, training

[4] a supervisor appointed by the university/institution in which the doctoral student will pursue another form of education: internship, internship, training

……
Date and signature of the doctoral student

8. Guardian's opinion:

.....

.....

.....

.....

.....

.....

.....

……
Date and signature of the guardian

Evaluation of implementation (incl./nzal) .....

Number of ECTS credits awarded.....

……
date and signature of the promoter

Note from the Dean's Office of the Doctoral School:

Received on .....

……..

date, signature of the dean's office employee

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 9/SDR/2022 of 1 April 2022

on the introduction of templates of documents related to the implementation of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in conjunction with § 15(3), § 17 section 4 and § 20 section 2 of the Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology, constituting an annex to Resolution No. 21/WAT/2021 of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following templates of documents related to the implementation of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology are introduced:
   1) Application for the implementation of the internship and appointment of the head of the internship, constituting Annex No. 1 to the decision,
   2) Report on the implementation of professional practice at the Military University of Technology, constituting Appendix No. 2 to the decision,
   3) Report on the implementation of another form of education, constituting Appendix No. 3 to the decision.

§ 2

1. The application referred to in § 1 section 1 shall be submitted by the doctoral student to the Dean's Office of the Doctoral School by the deadline of:
   1) 1 June, if the apprenticeship begins in the winter semester,
   2) 15 January, if the apprenticeship begins in the summer semester.
2. Professional practice can be carried out in various organizational units of the Military University of Technology. In this case, the doctoral student submits the application referred to in § 1 section 1 to the head of each organisational unit in which he/she plans to carry out the internshipwithin the deadlines referred to in paragraph 1.

3. The report referred to in § 1 section 1 point 2 is submitted by the doctoral student to the Dean's Office of the Doctoral School no later than by the end of each semester in which the professional practice was completed.
4. The report referred to in § 1 section 1 point 3 shall be submitted by the doctoral student to the Dean's Office of the Doctoral School no later than by the end of the semester in which he/she completed (completed) another form of education, regardless of the number of semesters in which it was implemented.

§ 3

The decision of the Director of the Military University of Technology Doctoral School No. 3/SDR/2020 of 19 November 2020 on the introduction of templates of documents related to the implementation of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology is no longer in force

§ 4

The decision enters into force on the day of signing.

Director
Doctoral School

(--) Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2022
of 1 April 2022

(name and surname of the doctoral student)	*(city, date of application)*
(scientific discipline)	
(email address)	
(title/degree, name and surname of the supervisor(s)	

(head of organizational unit)[1]

REQUEST

In accordance with the Regulations of the Doctoral School of the Military University of Technology Jarosław Dąbrowski, I would like to ask you to make it possible to carry out the

(name of the organizational unit)

professional practice in the form of conducting classes or participating in their conduct and appointing a practice manager.

Below I present the plan of professional practice in the above-mentioned organizational unit resulting from the Individual Education Program approved by the Director of the Doctoral School of the Military University of Technology.

Lp.	**Academic year**	**Semester**	**Number of hours of professional practice in the form of:**		**Total number of hours in an academic year** ***(max. 60 hours)***
			conducting didactic classes by a doctoral student	**participation of the doctoral student in teaching**	
1		**winter**			
2		**lukewarm**			
3		**winter**			
4		**lukewarm**			
5		**winter**			
6		**lukewarm**			
Together					

……
(signature of the PhD student)

[1] e.g. Dean of the Faculty of Military Technology, Director of the Institute of Optoelectronics

Annotation of the Director of the Doctoral School of the Military University of Technology

……
(date and signature of the Director of the Doctoral School)

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2022
of April 2022

(city, date of application)

REPORT
from the implementation of professional practice at WAT in the winter/summer semester[2] academic year

1. Name and surname of the doctoral student

2. Year/semester of doctoral student education - scientific discipline

3. Place of implementation (*organizational unit, faculty, institute)*

4. Stop./. science/profession, name and surname of the head of the practice[3]

5. Settlement of hours of professional practice

   1) Planned number of hours in semesters[4]:

III	IV	V	VI	VII

   2) Number of hours completed in the reporting semester: including in the form of:

   a) conducting didactic classes by a doctoral student

Lp.	Item Name	Form of classes (w/qw./lab/sem.)	Form of education (I/II/JSM/Course)	Number of hours	Comments
1.					
2.					
3.					
			A total of hours.		

   b) participation of the doctoral student in conducting classes[5]

Lp.	Description of the action (m.in. name of the course, course teacher, role of the doctoral student, etc.)	Number of hours	Comments
1.			
2.			
3.			
	A total of hours.		

[2] delete unnecessary
[3] in accordance with the Regulations of the WAT Doctoral School, the head of the organizational unit in which the doctoral student will carry out professional practice appoints a manager responsible for the implementation of professional practice by the doctoral student in the form of conducting classes or participating in conducting classes
[4] in accordance with the Individual Education Program
[5] Participation in conducting classes is understood as m.in: participation in classes as an observer, assistance to an academic teacher in conducting classes, preparation of a laboratory station or development of instructions for exercises

6. Information on the reasons for not completing the assumed number of hours of professional practice in the reporting semester and comments on its implementation

……
(date and signature of the doctoral student)

7. Opinion of the head of the practice:

8. Evaluation of the internship (incl.)

……
(date and signature of the head of the practice)

Note from the Dean's Office of the Doctoral School:

Received on .....

……..
(date, signature of the dean's office)

Appendix No. 3 to the Decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2022
of 1 April 2022

(city, date of application)

REPORT

from the implementation of another form of education

1. Name and surname of the doctoral student

2. Year/semester of doctoral student education - scientific discipline

3. Name of the form of education[6]

4. Place of implementation of the form of education *(university/institution, faculty – city, country)*

5. Date of implementation of the form of education *(start date – end date)*

6. Stop./. science/profession, name and surname of the guardian[7]

7. Settlement of hours:

1) planned number of hours and ECTS credits[8]	
2) number of hours completed	

8. Detailed scope *(description of activities – goal, tasks, duration, leader, achieved effects, etc.)*

[6] the name of another form of education provided in and outside the Military University of Technology, in another HEI or domestic or foreign institution included in the Individual Education Programme
[7] a supervisor indicated by the university/institution in which the doctoral student will pursue another form of education
[8] in accordance with the Individual Education Program

9. Information on the reasons for non-implementation of planned projects or the assumed number of hours and comments on its implementation

……
(date and signature of the doctoral student)

9. Guardian's opinion

……
(date and signature of the guardian)

10. Evaluation of the implementation of the form of education (incl./nzal)

……
(date and signature of the promoter)

Note from the Dean's Office of the Doctoral School:

Received on .....

……..
(date, signature of the dean's office)

Wojskowa Akademia Techniczna

Szkoła Doktorska SDR

Case No.:

Decision
Director of the Doctoral School of the Military University of Technology nr /SDR/ 14 2025 of 3 June 2025

on the determination of the template of the final report PhD student at the Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 21(5) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to Resolution No. 28/WAT/ 2024 of 25 April 2024 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

The following is introduced:
1) a template of the final report of the doctoral student of the Doctoral School of the Military University of Technology, constituting Annex No. 1 to the decision,
2) a template of the supervisor's final opinion, constituting Annex No. 2 to the decision.

§ 2

The decision enters into force on the day. Sign

Piotr Zalewski, PhD, Eng., Prof. WAT
Military University of Technology
/ document signed with a qualified electronic signature /

Prepared by: Dariusz Podbielski (SDR)
☎ tel. , e-mail: 2 61 837 561 dariusz.podbielski@wat.edu.pl

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 14/SDR/2025

of 3 June 2025

FINAL REPORT
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE MILITARY UNIVERSITY OF TECHNOLOGY

A. Information data

1. **Name and surname of the doctoral student**

2. **Period of education at the Doctoral School (year of commencement – year of completion)**

3. **Scientific discipline**

4. **Title/degree, name of the supervisor(s)**

5. **Title/degree, name and surname of the assistant supervisor**

B. Doctoral dissertation

1. **Topic of the doctoral dissertation**

2. **Form of the doctoral dissertation**

3. **Abstract of the doctoral dissertation** *(max. 1500 characters without spaces)*

4. **Dissertation-related keywords (up to 5 keywords)**

C. Scientific activity of a doctoral student during the period of education at the Doctoral School of the Military University of Technology

1) Publications

Lp.	Author, authors	Publication title	Publisher, ISBN number, year of publication or submission for publication	Number of points[1]
1.				
2.				
3.				

2) Completed presentations at national or international scientific conferences

Lp.	Conference name and venue (city, country)	Form of the conference	Form of Speech	Conference date
1.				
2.				
3.				

3) Participation in the organization of national or international scientific conferences

Lp.	Conference name and venue (city, country)	Form of organization	Conference date
1.			
2.			

[1] The number of points for publishing houses, scientific journals and peer-reviewed materials from international conferences included in the lists referred to in Article 267(3) of the Act of 20 July 2018. Law on Higher Education and Science

3.			

4) Implementation of a research internship, internship or study trip to a domestic or foreign university or scientific institution

Lp.	Type of trip	Name of the host university or institution	Place	Deadline
1.				
2.				
3.				

5) Participation in projects, grants, programs

Lp.	Name of the project, grant, program	Time of participation from- to	Institution financing /host /implementing	The role and participation of the doctoral student
1.				
2.				

6) Information about awards, distinctions

……

date and legible signature of the doctoral student

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 14/SDR/2025
of 3 June 2025

OPINION
SUPERVISOR'S FINAL [2]

1. **Name and surname of the doctoral student**

2. **Topic of the doctoral dissertation**

3. **Title/degree, name and surname of the supervisor**

4. **Evaluation of the result of the doctoral dissertation check using the Uniform Anti-Plagiarism System (JSA)** *(accept, disaccept, justification)*

5. **Supervisor's opinion on the doctoral dissertation**

6. **Evaluation of the doctoral dissertation** *(positive/negative)*

Attachment *– signed by the supervisor General Report on the JSA Anti-Plagiarism Survey*

[2] In the case of two or more promoters, each promoter shall prepare a separate opinion

……

date and legible signature of the supervisor

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No 07/SDR/2019 of 21 November 2019

on the introduction of a template for the report on subjects carried out as part of the educational programme at the Doctoral School of the Jarosław Dąbrowski Military University of Technology

Pursuant to § 6 section 4 point 11 of the Organisational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 13/RKR/2019 of 23 May 2019 on the granting of the Organisational Regulations of the Doctoral School of the Military University of Technology, it is decided as follows:

§ 1

1. Subject to paragraph 2, a template of the report on the subjects carried out as part of the curriculum at the Doctoral School, which shall be annexed to the decision, shall be introduced.
2. The formula referred to in paragraph 1 applies from the academic year 2019/2020 only for subjects for which the Subject Information Sheet (KIP) in the *"Methods and criteria of assessment"* section defines the report as an element of course credit, and included in the Curriculum of the Doctoral School of the Military University of Technology, which is an annex to the Resolution of the Senate of the Military University of Technology No. 36/WAT/2019 of 30 May 2019 on the establishment of the "Curriculum of Education at the Doctoral School of the Military University of Technology".

§ 2

The report on the subject *"Research Area Analysis"* is submitted by the doctoral student to the Dean's Office of the Doctoral School of the Military University of Technology, within 14 days from the date of the evaluation made by the supervisor.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology No. 07/SDR/2019
of 21 November 2019

Warsaw, dn.....

REPORT
DOCTORAL STUDENT OF THE DOCTORAL SCHOOL

Academic year ...../.....

Semester.....

Item.....

1. Name and surname of the PhD student:

   .....

2. Scientific discipline: .....

3. Title/degree, name and surname of the supervisor:

   ……..

4. Content of the report

/the content of the report should not exceed 3 A4 pages with normal margins, using Arial 12 pt font and single space, The structure of the content of the report as well as the main issues and the manner of presentation of proposals by the doctoral student are determined by the supervisor or the course supervisor/

……
date and legible signature of the doctoral student

5. Opinion of the report by the supervisor/lecturer of the course

   ……..

   ……..

   ……..

6. Assessment of the ..... report

……
date and legible signature of the supervisor/lecturer of the course

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 3/SDR/2022 of 12 January 2022

on the determination of the template of the report on the subject of Research Area Analysis for PhD students of the Doctoral School of the Military University of Technology

Pursuant to § 6 section 5 point 11 of the Organisational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organisational Regulations of the Doctoral School of the Military University of Technology, it is decided as follows:

§ 1

A template of the report on the subject of Research Area Analysis for PhD Students of the Doctoral School of the Military University of Technology, which is attached to the decision, is hereby defined.

§ 2

The report referred to in § 1 shall be submitted by the doctoral student to the supervisor at least 7 days before the date of the seminar in the subject of Research Area Analysis, and after the supervisor's assessment, it shall be submitted to the Dean's Office of the Doctoral School of the Military University of Technology, by 31 March.

§ 3

The decision enters into force on the day of signing.

§ 4

The decision of the Director of the Military University of Technology Doctoral School No. 07/SDR/2019 of 21 November 2019 on the introduction of a template report on subjects carried out as part of the education programme at the Jarosław Dąbrowski Military University of Technology Doctoral School is hereby repealed.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof.
WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the WAT Doctoral School No. .3/SDR/2022
of 12 January 2022

Wojskowa Akademia Techniczna

Szkoła Doktorska SDR

.....Dn.....

REPORT
FROM THE SUBJECT OF RESEARCH AREA ANALYSIS

1. Name and surname of the doctoral student

2. Title/degree, name of the supervisor(s)

3. Planned topic of the doctoral dissertation

4. Content of the report - results of the analysis of the state of knowledge in the field of selected research issues, literature review, definition of the research problem (aim, research questions, hypotheses) and preliminary determination of the methodology[1]

.....

[1] Max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5, justified text.

date and legible signature of the doctoral student

5. Comments from the supervisor(s)

6. Evaluation of the report - passed/failed[2]

……
date and legible signature of the supervisor(s)

[2] delete unnecessary

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 31/SDR/2023 of 28 November 2023

on the determination of the template of the report on the implementation of the subject Research Area Analysis for PhD students of the Military University of Technology Doctoral School and the template of the opinion of the supervisor and assistant supervisor

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 46/RKR/2023 of 4 July 2023 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, it is decided as follows:

§ 1

1. The following is introduced for doctoral students of the Military University of Technology Doctoral School:
   1) a template of the report on the implementation of the subject Analysis of the Research Area, constituting Annex No. 1 to the decision,
   2) a template of the supervisor's opinion, constituting Annex No. 2 to the decision;
   3) Template of the opinion of the auxiliary supervisor[1], constituting Annex 3 to the decision.
2. The templates referred to in paragraph 1 shall be valid from the academic year 2023/2024.

§ 2

1. The report referred to in § 1 section 1 point 1 shall be submitted by the doctoral student to the supervisor or supervisors, and in the case of doctoral students pursuing education under the "Implementation Doctorate" programme, also to the assistant supervisor, at least 7 days before the date of the seminar on the implementation of the subject Research Area Analysis.
2. The documents referred to in § 1 section 1 shall be submitted by the doctoral student in paper or electronic form to the Dean's Office of the Doctoral School of the Military University of Technology within 30 days from the date of the seminar[2].

§ 3

[1] applies only to assistant supervisors of doctoral students pursuing education under the "Implementation Doctorate" program

[2] the opinion of the assistant supervisor is provided only by doctoral students pursuing education under the "Implementation Doctorate" program

The decision of the Director of the Jarosław Dąbrowski Military University of Technology Doctoral School No. 3/SDR/2022 of 12 January 2022 on the determination of the template of the report on the subject Research Area Analysis for PhD students of the Military University of Technology Doctoral School is no longer in force.

§ 4

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. .31/SDR/2023
of 28 November 2023

REPORT
from the implementation of the subject Research Area Analysis

1. **Name and surname of the doctoral student**

2. **Scientific discipline**

3. **Title/degree, name of the supervisor(s)**

4. **Title/degree, name and surname of the assistant supervisor/assistant supervisor**

5. **Planned topic of the doctoral dissertation**

6. **Content of the report** - *results of the analysis of the state of knowledge in the field of selected research issues, literature review, definition of the research problem (aim, research questions, hypotheses), preliminary determination of the methodology and preliminary determination of the stages of preparation of the doctoral dissertation*[3]

Attachment – draft presentation

.....
Date and signature of the doctoral student

[3] Max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1, justified text.

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No.31/SDR/2023
of 28 November 2023

SUPERVISOR'S OPINION
concerning the implementation by a doctoral student of the Doctoral School of the Military University of Technology[4] subject of Research Area Analysis

1. **Name and surname of the doctoral student**

2. **Title/degree, name and surname of the supervisor**

3. **Supervisor's opinion**

4. **Evaluation of the doctoral student's report (appl./nzal.)**

Evaluation of the report	

.....
date and signature of the promoter

[4] In the case of two or more supervisors, each supervisor prepares a separate opinion

Appendix No. 3 to the Decision
Director of the Doctoral School of the Military University of Technology No. 31/SDR/2023
of 28 November 2023

OPINION
ASSISTANT SUPERVISOR
concerning the report of a PhD student of the Doctoral School of the Military University of Technology on the implementation of the subject Research Area Analysis [5]

1. **Name and surname of the doctoral student**

2. **Title/degree, name and surname of the assistant supervisor**

3. **Opinion of the assistant supervisor**

.....

Date and signature of the assistant supervisor

[5] only for doctoral students pursuing education under the "Implementation Doctorate" program

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
No. 1/SDR/2021 of 20 January 2021

on the determination of the template of the semester report of doctoral students of the Jarosław Dąbrowski Doctoral School of the Military University of Technology on the implementation of the Individual Research Plan and the template of the opinion of the supervisor(s)

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, in connection with § 14 section 1 point 2 of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019. on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following is introduced:
   1) a template of the semester report on the implementation of the Individual Research Plan, hereinafter referred to as the report, constituting Annex No. 1 to the decision,
   2) A template of the supervisor's opinion, constituting Annex No. 2 to the decision.
2. The templates referred to in paragraph 1 shall be valid from the academic year 2020/2021.

§ 2

1. The doctoral student submits the report with attachments in paper or electronic form to the supervisor and to the Dean's Office of the Doctoral School within 7 days from the date of the doctoral seminar conducted in semesters 3 to 7, excluding semester 4.
2. For semester 4, the templates of documents prepared by the doctoral student as part of the mid-term evaluation are determined by a separate decision.
3. Within 14 days from the date of receipt of the report from the doctoral student, the supervisor submits to the Dean's Office of the Doctoral School of the Military University of Technology in paper or electronic form the opinion referred to in § 1 section 1 point 2.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof.
WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2021
of 20 January 2021

Warsaw, dn.....

SEMESTER REPORT
DOCTORAL STUDENT OF THE DOCTORAL SCHOOL

Applies to the semester..... Academic year. ……

1. Name and surname of the doctoral student:

   .....

2. Scientific discipline: .....

3. Title/degree, name and surname of the supervisor(s):

   ……..

   ……..…

4. Title/degree, name and surname of the assistant supervisor:

   ……..……

5. **Information on the implementation of tasks included in the semester ..... in the detailed schedule for the preparation of the doctoral dissertation and scientific undertakings of the Individual Research Plan.**

   1) Implementation of planned stages and issues within the doctoral dissertation, including information on the implementation of unrealized issues indicated in the previous report

      (the content of the information should not exceed 3 A4 pages with the normal size of margins, using the Arial font 12 points and a single space – the information can be presented below or as Appendix No. 2)

      ……

      ……

      ……

      a) completed .....% of the doctoral dissertation in the semester in relation to the assumed .....% for this semester, which in total constitutes .....% of the total doctoral dissertation,

b) In the event of failure to complete the issues for this stage and semester or failure to meet the assumed percentage, the reasons and deadline for completion should be stated

……

……

……

……

2) Completed presentations at national or international scientific conferences

……

……

(name of the conference, form of presentation, date)

3) Participation in the organization of national or international scientific conferences

……

……

(name of the conference, form of organization, date)

4) Implementation of a research internship or study trip to a domestic or foreign university or scientific institution

……

(type of trip, name of the host university or institution, place, date)

5) Publications (dissemination of R+D results on the basis of open access)

……

(publication name, publisher, number, ISBN, date of publication or submission for printing)

6) Additional information on the implementation of the individual research plan

……

……

Date and legible signature of the doctoral student

Attachments:

1. Appendix no. 1 - presentation of a PhD student from the doctoral seminar
2. Appendix no. 2 - information on the implementation of tasks – point 5 point 1 (optional)
3. Appendix no. 3 - other documents, e.g. chapter of the doctoral dissertation

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2021
of 20 January 2021

Warsaw, dn.....

OPINION
SUPERVISOR(S)

Applies to the semester..... Academic year. …….

1. Name and surname of the PhD student:

   .....

2. Title/degree, name and surname of the supervisor(s):

   ……

   ……

3. Opinion of the supervisor(s):

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

   ……

4. Evaluation of a PhD student's presentation at a doctoral seminar .....
   (Zs/Zal)

5. Assessment of the ..... report
   (Zs/Zal)

……
Date and signature of the supervisor(s)

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
No. 4/SDR/2022 of 19 January 2022

on the determination of the template of the semester report of a doctoral student of the Doctoral School of the Military University of Technology on the implementation of the Individual Research Plan and the template of the semester opinion of the supervisor

Pursuant to § 6(5)(11) of the Organisational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organisational Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology, in connection with § 13(1)(2) of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to Resolution No. 21/WAT/2021 of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following is introduced:
   1) a template of the semester report on the implementation of the Individual Research Plan, hereinafter referred to as the report, constituting Annex No. 1 to the decision,
   2) A template of the supervisor's opinion, constituting Annex No. 2 to the decision.
2. The templates referred to in paragraph 1 shall be valid from the academic year 2021/2022.

§ 2

1. The doctoral student submits the report with attachments in paper or electronic form to the supervisor and to the Dean's Office of the Doctoral School within 7 days from the date of the doctoral seminar conducted in semesters 3 to 7, excluding semester 4.
2. For semester 4, the templates of documents prepared by the doctoral student as part of the mid-term evaluation are determined by a separate decision.
3. Within 14 days from the date of receipt of the report from the doctoral student, the supervisor submits to the Dean's Office of the Doctoral School of the Military University of Technology in paper or electronic form the opinion referred to in § 1 section 1 point 2.

§ 3

The decision enters into force on the day of signing.

§4

The decision of the Director of the Jarosław Dąbrowski Doctoral School of the Military University of Technology No. 1/SDR/2021 of 20 January 2021 on the determination of the template of the semester report of doctoral students of the Jarosław Dąbrowski Doctoral School of the Military University of Technology on the implementation of the Individual Research Plan and the template of the opinion of the supervisor(s) is hereby repealed

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof.
WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 4/SDR/2022
of 19 January 2022

SEMESTER REPORT
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE MILITARY UNIVERSITY OF TECHNOLOGY
FROM THE IMPLEMENTATION OF AN INDIVIDUAL RESEARCH PLAN

1. **The academic year and semester of education of the doctoral student to whom the report relates**

2. **Name and surname of the doctoral student**

3. **Scientific discipline**

4. **Title/degree, name of the supervisor(s)**

5. **Title/degree, name and surname of the assistant supervisor**

6. **Topic of the doctoral dissertation**

7. **Individual Research Plan (IPB) – plan for the reporting semester**[1]

Stages of preparing a doctoral dissertation and planned to be implemented	Expected participation in the entire dissertation (%)

[1] on the basis of the Individual Research Plan of the PhD student

8. Individual Research Plan (IPB) – implementation in the reporting semester

1) Information on the implementation of planned stages and issues[2]

2) percentage of implementation of issues planned in the reporting semester, share in the total dissertation (%)

3) information on unfulfilled issues or failure to meet the percentage share assumed in point 7 in the entire hearing[3]

4) information on the implementation of unfulfilled issues indicated in the previous semester report[4]

5) information on the implementation of additional issues, including issues planned in the next semesters of education

6) additional information on the implementation of the IPB[5]

[2] Max. 5000 characters without spaces, Arial font, normal style, size 12, line spacing 1.5, justified text.

[3] The reasons and the planned date of completion of the issues should be stated

[4] does not apply to the report for semester III, in the case of the report for semester V, reference should be made to the unfulfilled issues included in the Interim Report

[5] Information on planned changes in IPB

9. Status of doctoral dissertation preparation (%)[6]

10. Scientific activity in the reporting semester

1) completed presentations at national or international scientific conferences *(name of the conference, form of presentation, date)*

2) participation in the organization of national or international scientific conferences *(name of the conference, form of presentation, date)*

3) Implementation of a research internship or study trip to a domestic or foreign university or scientific institution *(type of trip, name of the university or host institution, place, date)*

4) Publications - dissemination of R+D results on the basis of open access *(publication name, publisher, number, ISBN, date of publication or submission for printing)*

5) Information on unrealized projects of the doctoral student's scientific activity planned in the reporting semester[7]

6) Additional information *(awards, distinctions, other forms of scientific activity)*

.....

date and legible signature of the doctoral student

Attachments:

1. Appendix no. 1 - presentation of a PhD student from the doctoral seminar
2. Appendix no. 2 - other documents, e.g. chapter of the doctoral dissertation

[6] status at the end of the reporting semester - % of preparation of the entire doctoral dissertation

[7] reference to planned projects in the categories indicated in points 1-4

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 4/SDR/2022
of 19 January 2022

SEMESTER OPINION OF THE SUPERVISOR
CONCERNING THE IMPLEMENTATION OF AN INDIVIDUAL RESEARCH PLAN BY A DOCTORAL STUDENT OF THE DOCTORAL SCHOOL OF THE MILITARY UNIVERSITY OF TECHNOLOGY[8]

1. **Academic year and semester of doctoral student education**

2. **Name and surname of the doctoral student**

3. **Title/degree, name and surname of the supervisor**

4. **Supervisor's opinion – assessment of the quality and timeliness of the implementation of the planned stages and issues in the reporting semester**

5. **Semester grade of the PhD student (ZAL/NZAL)**

evaluation of presentations at the doctoral seminar	
Evaluation of the report	

[8] In the case of two or more supervisors, each supervisor prepares a separate opinion

……

date and signature of the promoter

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
1/SDR/2023 of 12 January 2023

on the determination of the template of the semester report of a doctoral student of the Military University of Technology Doctoral School on the implementation of the Individual Research Plan and the template of the semester opinion of the supervisor and assistant supervisor

Pursuant to § 6(5)(11) of the Organisational Regulations of the Doctoral School of the Military University of Technology, which is an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organisational Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology, in connection with § 13(1)(2) of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to Resolution No. 21/WAT/2021 of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following is introduced:
   1) a template of the semester report on the implementation of the Individual Research Plan, constituting Annex No. 1 to the decision,
   2) A template of the supervisor's semester opinion, constituting Annex No. 2 to the decision.
   3) Template of the Assistant Supervisor's Semester Opinion[1], constituting Annex No. 3 to the Decision.
2. The templates referred to in paragraph 1 shall be valid from the academic year 2022/2023.

§ 2

1. The report referred to in § 1 section 1 point 1 shall be submitted by the doctoral student to the supervisor or supervisors, and in the case of doctoral students pursuing education under the "Implementation Doctorate" programme, also to the assistant supervisor, at least 7 days before the date of the doctoral seminar carried out in semesters 3, 5, 6 and 7.
2. The documents referred to in § 1 section 1 shall be submitted by the doctoral student in paper or electronic form to the Dean's Office of the Doctoral School of the Military University of Technology within 30 days from the date of the seminar[2].

[1] applies only to supervisors indicated by the employer of doctoral students pursuing education under the "Implementation Doctorate" programme

[2] the opinion of the assistant supervisor is provided only by doctoral students pursuing education under the "Implementation Doctorate" program

§ 3

The decision of the Director of the Military University of Technology Doctoral School No. 4/SDR/2022 of 19 January 2022 on the determination of the template of the semester report of a doctoral student of the Jarosław Dąbrowski Doctoral School of Military University of Technology on the implementation of the Individual Research Plan and the template of the supervisor's semester opinion is hereby repealed.

§ 4

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof.
WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2023
of 12 January 2023

SEMESTER REPORT
PhD student at the Doctoral School of the Military University of Technology
from the implementation of the Individual Research Plan

1. **The academic year and semester of education of the doctoral student to whom the report relates**

2. **Name and surname of the doctoral student**

3. **Scientific discipline**

4. **Title/degree, name of the supervisor(s)**

5. **Title/degree, name and surname of the assistant supervisor**

6. **Topic of the doctoral dissertation**

7. **Individual Research Plan (IPB) – plan for the reporting semester**[3]

Stages of preparing a doctoral dissertation and planned to be implemented	Expected participation in the total dissertation in the reporting semester (%)

[3] on the basis of the Individual Research Plan of the PhD student

8. Individual Research Plan (IPB) – implementation in the reporting semester

1) Information on the implementation of planned stages and issues[4]

2) percentage of completion of issues planned in the reporting semester, completed share in the total dissertation in the reporting semester (%)

3) information on unfulfilled issues or failure to meet the percentage share assumed in point 7 in the entire hearing[5]

4) information on the implementation of unfulfilled issues indicated in the previous semester report[6]

5) information on the implementation of additional issues, including issues planned in the next semesters of education

6) additional information on the implementation of the IPB[7]

[4] Max. 5000 characters without spaces, Arial font, normal style, size 12, line spacing 1, justified text.

[5] The reasons and the planned date of completion of the issues should be stated

[6] does not apply to the report for semester III, in the case of the report for semester V, reference should be made to the unfulfilled issues included in the Interim Report

[7] information on planned changes in IPB

9. Status of doctoral dissertation preparation (%)[8]

10. Scientific activity in the reporting semester

1) completed presentations at national or international scientific conferences *(name of the conference, form of presentation, date)*

2) participation in the organization of national or international scientific conferences *(name of the conference, form of presentation, date)*

3) Implementation of a research internship or study trip to a domestic or foreign university or scientific institution *(type of trip, name of the university or host institution, place, date)*

4) Publications - dissemination of R+D results on the basis of open access *(publication name, publisher, number, ISBN, date of publication or submission for printing)*

5) Information on unrealized projects of the doctoral student's scientific activity planned in the reporting semester[9]

6) Additional information *(awards, distinctions, other forms of scientific activity)*

……

date and legible signature of the doctoral student

Attachments:

1. Appendix no. 1 - presentation of the doctoral student at the doctoral seminar
2. Appendix no. 2 - other documents, e.g. chapter of the doctoral dissertation, first page of the article, diplomas, certificates

[8] status at the end of the reporting semester - % of preparation of the entire doctoral dissertation since the beginning of education in SDR

[9] reference to planned projects in the categories indicated in points 1-4

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2023
of 12 January 2023

SEMESTER OPINION
PROMOTER
concerning the implementation of the Individual Research Plan by a doctoral student of the WAT Doctoral School[10]

1. **Academic year and semester of doctoral student education**

2. **Name and surname of the doctoral student**

3. **Title/degree, name and surname of the supervisor**

4. **Supervisor's opinion – assessment of the quality and timeliness of the implementation of the planned stages and issues in the reporting semester**

5. **Semester grade of the PhD student (ZAL/NZAL)**

evaluation of presentations at the doctoral seminar	
Evaluation of the report	

[10] In the case of two or more supervisors, each supervisor prepares a separate opinion

……
date and signature of the promoter

Appendix No. 3 to the Decision
Director of the Doctoral School of the Military University of Technology No. 1/SDR/2023
of 12 January 2023

SEMESTER OPINION
ASSISTANT SUPERVISOR
concerning the implementation of the Individual Research Plan by a doctoral student of the WAT Doctoral School [11]

1. **Academic year and semester of doctoral student education**

2. **Name and surname of the doctoral student**

3. **Title/degree, name and surname of the assistant supervisor**

4. **Opinion of the assistant supervisor on the progress of the doctoral student in the implementation of the individual research plan in the reporting semester**

[11] only for doctoral students pursuing education under the "Implementation Doctorate" program

……

Date and signature of the assistant supervisor

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
No 12/SDR/2025 of 20 May 2025

on the determination of the template of the semester report of a doctoral student of the Military University of Technology Doctoral School on the implementation of the Individual Research Plan and the template of the semester opinion of the supervisor and assistant supervisor

Pursuant to § 6 section 5 point 11 of the Organizational Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Ordinance of the Rector of the Military University of Technology No. 48/RKR/2019 of 28 November 2019 on the granting of the Organizational Regulations of the Doctoral School of the Military University of Technology, in connection with § 13 section 2 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to the Resolution No. 28/WAT/2024 of 25 April 2024 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following is introduced:
   1) a template of the semester report on the implementation of the Individual Research Plan, constituting Annex No. 1 to the decision,
   2) A template of the supervisor's semester opinion, constituting Annex No. 2 to the decision.
   3) Template of the Assistant Supervisor's Semester Opinion[1], constituting Annex No. 3 to the Decision.

§ 2

1. The semester reports referred to in § 1 section 1 point 1 shall be submitted by the doctoral student for each semester in which the individual research plan is implemented, also during the period of extension of the deadline for submitting the doctoral dissertation, with the exception of semesters in which the doctoral student:
   1) is subject to a mid-term evaluation;
   2) will submit his doctoral dissertation.
2. The semester report is submitted by the doctoral student to the supervisor or supervisors, and in the case of doctoral students pursuing education under the "Implementation Doctorate" program, also to the assistant supervisor:
   1) at least 7 days before the date of the doctoral seminar carried out in semesters 3, 5, 6 and 7 together with the presentation project.

[1] applies to assistant supervisors of doctoral students pursuing education under the "Implementation Doctorate" program

2) at least 7 days before the end of each semester during the extension of the deadline for submitting the doctoral dissertation, subject to paragraph 1 point 2 and paragraph 3.

3. The semester report together with the opinion of the supervisor or the opinion of the supervisor and assistant supervisor is [2] submitted by the doctoral student in paper or electronic form to the Dean's Office of the Doctoral School of the Military University of Technology on the following dates:
   1) up to 30 calendar days from the date of the seminar, in the cases referred to in paragraph 2 point 1;
   2) up to 30 calendar days from the beginning of the next semester, in the cases referred to in paragraph 2 point 2.

§ 3

The decision of the Director of the Jarosław Dąbrowski Military University of Technology Doctoral School No. 1/SDR/2023 of 12 January 2023 on the determination of the template of the semester report of a doctoral student of the Doctoral School of the Military University of Technology on the implementation of the Individual Research Plan and the template of the semester opinion of the supervisor and assistant supervisor is no longer in force.

§ 4

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

[2] only for doctoral students pursuing education under the "Implementation Doctorate" program

Appendix No. 1 to the decision
Director of the WAT Doctoral School No. 12/SDR/2025
of 20 May 2025

SEMESTER REPORT
PhD student at the Doctoral School of the Military University of Technology
from the implementation of the Individual Research Plan

1. **The academic year and semester of education of the doctoral student to whom the report relates**

2. **Name and surname of the doctoral student**

3. **Scientific discipline**

4. **Title/degree, name of the supervisor(s)**

5. **Title/degree, name and surname of the assistant supervisor**

6. **Topic of the doctoral dissertation**

7. **Individual Research Plan (IPB) – plan for the reporting semester**[3]

Stages of preparing a doctoral dissertation and planned to be implemented	Expected participation in the total dissertation in the reporting semester (%)

[3] on the basis of the Individual Research Plan of the PhD student

8. Individual Research Plan (IPB) – implementation in the reporting semester

1) information on the implementation of planned stages and issues[4]

2) Completed share in the total dissertation in the reporting semester (%)

3) information on unfulfilled issues or failure to meet the percentage share assumed in point 7 in the entire hearing[5]

4) information on the implementation of unfulfilled issues indicated in the previous semester report[6]

5) information on the implementation of additional issues, including issues planned in the next semesters of education

6) additional information on the implementation of the IPB[7]

[4] Max. 5000 characters without spaces, Arial font, normal style, size 12, line spacing 1, justified text.

[5] The reasons and the planned date of completion of the issues should be stated

[6] does not apply to the report for semester III, in the case of the report for semester V, reference should be made to the unfulfilled issues included in the Interim Report

[7] information on planned changes in IPB

9. Status of doctoral dissertation preparation (%)[8]

10. Scientific activity in the reporting semester

1) publication activity *(name of publication, publishing house, number, ISBN, date of publication or submission for publication)*

2) completed presentations at national or international scientific conferences *(name of the conference, form of presentation, date)*

3) participation in the organization of national or international scientific conferences *(name of the conference, form of presentation, date)*

4) implementation of a research internship or study trip to a domestic or foreign university or scientific institution *(type of trip, name of the host university or institution, place, date)*

5) information on unrealized and planned in the reporting semester undertakings of the doctoral student's scientific activity[9]

6) additional information *(awards, distinctions, other forms of scientific activity)*

……

date and legible signature of the doctoral student

[8] status at the end of the reporting semester - % of preparation of the entire doctoral dissertation since the beginning of education in SDR

[9] reference to planned projects in the categories indicated in points 1-4

Appendix No. 2 to the decision
Director of the WAT Doctoral School No. 12/SDR/2025
of 20 May 2025

SEMESTER OPINION
PROMOTER
concerning the implementation of the Individual Research Plan by a doctoral student of the WAT Doctoral School[10]

1. **Academic year and semester of doctoral student education**

2. **Name and surname of the doctoral student**

3. **Title/degree, name and surname of the supervisor**

4. **Supervisor's opinion – assessment of the quality and timeliness of the implementation of the planned stages and issues in the reporting semester**

[10] In the case of two or more supervisors, each supervisor prepares a separate opinion

5. Semester grade of the PhD student (ZAL/NZAL)[11]

Overall Rating	
evaluation for the doctoral seminar[12]	
Grade for the semester report	

.....

date and signature of the promoter

[11] the semester evaluation includes the evaluation of the presentation at the doctoral seminar and the evaluation of the report,
with the proviso that the grade for semester VIII and semesters during the period of extension of the deadline for submitting the doctoral dissertation includes only the evaluation of the semester report

[12] does not apply to the period of extension of the deadline for submitting a doctoral dissertation

Appendix No. 3 to the Decision
Director of the WAT Doctoral School No. 12/SDR/2025
of 20 May 2025

SEMESTER OPINION
ASSISTANT SUPERVISOR
concerning the implementation of the Individual Research Plan by a doctoral student of the WAT Doctoral School [13]

1. **Academic year and semester of doctoral student education**

2. **Name and surname of the doctoral student**

3. **Title/degree, name and surname of the assistant supervisor**

4. **Opinion of the assistant supervisor on the progress of the doctoral student in the implementation of the individual research plan in the reporting semester**

.....

Date and signature of the assistant supervisor

[13] only for doctoral students pursuing education under the "Implementation Doctorate" program

Case No.: 208562

Decision
Director of the Jarosław Dąbrowski
Doctoral School of the Military

No 57/SDR/2024 of 23 December 2024

on the introduction of the Regulations for the professional practice of doctoral students Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 17(8) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to Resolution No. 28/WAT/ 2024 of 25 April 2024 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

The Regulations of Professional Practice of Doctoral Students of the Doctoral School of the Military University of Technology, attached to this Decision, are hereby introduced.

§ 2

The Decision of the Director of the Doctoral School of the Jarosław Dąbrowski Military University of Technology No. 9/SDR/2022 of 1 April 2022 on the introduction of templates of documents related to the implementation of professional practice and other forms of education by doctoral students of the Doctoral School of the Military University of Technology is repealed

§ 3

The decision enters into force on the day of signing.

Dariusz Podbielski, PhD, Eng.
Chief Specialist - Deputy Director of the
Military University of Technology
/ **document signed with a qualified electronic signature** /

Prepared by: Dariusz Podbielski (KSD)
☎ Tel. 261837561, e-mail: dariusz.podbielski@wat.edu.pl

Appendix to the decision
of the Director of the Doctoral School of the Military
University of Technology No. 57/SDR/2024
of 23 December 2024

Rules

professional practice of doctoral students of the Military University of Technology Doctoral School

General assumptions

§ 1

The Regulations of Professional Practice of PhD Students of the Military University of Technology Doctoral School, hereinafter referred to as the "Regulations", define the detailed rules for the implementation and crediting of professional practice by PhD students of the Doctoral School of the Military University of Technology.

Purpose of the apprenticeship and learning outcomes

§ 2

1. Professional practice enables the doctoral student to gain practical experience, develop organizational and didactic competencies, and prepare for a future scientific or professional career.
2. The aim of the professional practice is to prepare doctoral students for effective and comprehensive functioning both in the academic environment and outside it, while developing didactic, analytical and interpersonal skills, in particular acquiring the ability to conduct classes properly, including their organization, taking into account the search for and selection of appropriate teaching methods and the use of new technologies in didactics.
3. After completing the professional practice, the doctoral student should achieve the specified
   in the curriculum, learning outcomes in the field of:
   1) methods and techniques of conducting didactic classes (D_W WAT01);
   2) Preparation and carry out in modern way classes didactic related to the scientific discipline (D_U WAT01);
   3) independently planning and acting for one's own development and inspiring and organizing the development of others (D_U03);
   4) initiating a debate (D_U09);
   5) planning a class or a group of classes and implementing them using modern methods and tools (D_U13);
   6) taking up challenges in the professional and public spheres, taking into account their ethical dimension and responsibility for their consequences, and shaping models of appropriate conduct in such situations (D_K02);
   7) initiating actions in the public interest (D_K07).

Rules for the implementation of professional practice

§ 3

1. During the course of education at the Doctoral School, the doctoral student undergoes professional practice in the form of conducting classes or participating in their conduct in the extent specified in the individual education program, subject to paragraph 2.
2. Professional practice may be carried out in semesters III to VII in general terms from 20 to 180 hours, with the proviso that there may not be more than 60 hours in an academic year.
3. Regardless of the number of hours of practice and the number of semesters of implementation, 1 ECTS credit is assigned to professional practice.
4. Professional practice may take place at the Military University of Technology, at domestic and foreign universities and scientific institutions, as well as at enterprises whose activities are related to the subject of the doctoral dissertation.
5. Teaching classes carried out as part of professional practice can be conducted in bachelor's, engineering or master's studies, postgraduate studies, doctoral school, courses and trainings. A doctoral student is obliged to comply with the regulations applicable to the lecturers.
6. In special and justified cases (e.g. disability of a doctoral student), the supervisor may exempt the doctoral student from the obligation to undergo professional practice by indicating an additional optional subject or another form of education in the amount of at least 2 ECTS credits. Information on exemption from professional practice is provided in Appendix No. 3 to the individual education programme of a doctoral student.
7. Conducting classes consists in conducting didactic classes independently in the form of exercises, laboratories, seminars, seminars, seminars, lectures, seminars, workshops.
8. Participation in conducting classes consists of:
   1) participation in conducting classes,
   2) observation of didactic classes,
   3) performing didactic tasks specified by the academic teacher conducting the classes.
9. Professional practice can take place in a stationary, remote or hybrid form.

§ 4

1. The application for the implementation of the internship and the appointment of the head of the internship is submitted by the doctoral student to the head of the organizational unit in which the internship will be carried out through the Director of the Doctoral School by the deadline of:
   1) 1 June, if the apprenticeship begins in the winter semester,
   2) 15 January, if the apprenticeship begins in the summer semester.
2. The template of the application referred to in paragraph 1 is contained in Appendix No. 1 to the Regulations.
3. Professional practice can be carried out in various organizational units. In this case, the doctoral student submits the application referred to in § 4 section 1 to the head of each organisational unit in which he or she plans to carry out the practice, within the deadlines referred to in paragraph 1.
4. Upon the request referred to in paragraph 1, the head of the organisational unit shall appoint a head of practice responsible for the implementation by the doctoral student

professional practice in the form of conducting classes or participating in their conduct.

5. Providing doctoral students with the opportunity to conduct or participate in teaching classes is ensured by the head of the organisational unit and the head of practice appointed by him.
6. The decision regarding the organisation of the internship, the choice of dates and form of classes is made by the head of the internship by assigning didactic tasks to the doctoral student for each semester of the internship specified in the application referred to in paragraph 1.
7. Direct substantive supervision over the completion of professional practice by the doctoral student, including preparation for conducting and conducting didactic classes, is exercised by the head of the practice.

§ 5

1. A doctoral student does not receive remuneration for didactic classes conducted as part of professional practice, subject to paragraph 2.
2. A doctoral student who is an academic teacher may, with the consent of the supervisor, include classes conducted as part of the teaching workload.
3. If all hours of professional practice included in the individual curriculum are counted as classes within the pensum, the doctoral student does not submit the application referred to in § 4 section 1.

Rules for crediting professional practice

§ 6

1. A professional practice is subject to credit for the generalized grade passed/failed (passl/no pass).
2. Credit for professional practice and entry in the USOS system is made by:
   1) the head of the practice, in the case of an internship at the Military University of Technology;
   2) supervisor, in the case of internship outside the Military University of Technology.
3. At the end of each semester of the internship, the doctoral student submits a report on the implementation of the internship to the head of the internship. The template of the report is specified in Appendix No. 2 to the Regulations.
4. In the case referred to in § 5 section 2, the head of the practice is the doctoral student's direct superior.
5. After receiving the report referred to in paragraph 3, the head of the practice prepares an opinion on the implementation of the internship by the doctoral student and makes an assessment for a generalized assessment.
6. A doctoral student, no later than by the end of each semester in which he/she completed his/her professional practice, submits the report referred to in paragraph 3 to the Dean's Office of the Doctoral School, subject to paragraph 6.
7. In the case of professional practice outside the Military University of Technology, the report must include the supervisor's assessment. Before issuing the grade, the supervisor may ask the head of the practice for additional information regarding the implementation of the internship by the doctoral student.
8. In the event of failure to complete the professional practice, the Director of the Doctoral School, after agreement with the supervisor, may decide to re-implement the professional practice in the next semester or to initiate the procedure of removing the doctoral student from the list of doctoral students.

9. In the case of repeating professional practice, failure to obtain a credit results in the initiation by the Director of the Doctoral School of the procedure of deleting the doctoral student from the list of doctoral students.

Final provisions

§ 7

In matters not regulated by these regulations, decisions are made by the Director of the Doctoral School of the Military University of Technology.

Appendix No. 1 to the Regulations
internships of doctoral students
WAT Doctoral School

(name and surname of the doctoral student)	*(city, date of application)*
(scientific discipline)	
(email address)	
(title/degree, name and surname of the supervisor(s)	

(head of organizational unit)[1]

REQUEST

In accordance with the Regulations of the Military University of Technology Doctoral School, I would like to ask you to allow the implementation of the

(name of the organizational unit)

professional practice in the form of conducting classes or participating in their conduct and appointing a practice manager.

Below I present the plan of professional practice in the above-mentioned organizational unit resulting from the Individual Education Program approved by the Director of the Doctoral School of the Military University of Technology.

Lp.	**Academic year**	**Semester**	**Number of hours of professional practice in the form of:**		**Total number of hours in an academic year** ***(max. 60 hours)***
			conducting didactic classes by a doctoral student	**participation of the doctoral student in teaching**	
1		**winter**			
2		**lukewarm**			
3		**winter**			
4		**lukewarm**			
5		**winter**			
Together					

……
(signature of the PhD student)

Annotation of the Director of the Doctoral School of the Military University of Technology

……
(date and signature of the Director of the Doctoral School)

[1] e.g. dean, director,

Appendix No. 2 to the Regulations
internships of doctoral students
WAT Doctoral School

(city, date of application)

REPORT
from the implementation of professional practice in the winter/summer semester[2] academic year

1. Name and surname of the doctoral student
2. Year/semester of doctoral student education - scientific discipline
3. Place of implementation (*university*, *organizational unit, faculty, institute)*
4. Stop./. science/profession, name and surname of the head of the practice[3]
5. Settlement of hours of professional practice

   1) Planned number of hours in semesters[4]:

III	IV	V	VI	VII

   2) Number of hours completed in the reporting semester:
   including in the form of:

   a) conducting didactic classes by a doctoral student

Lp.	Item Name	Form of classes (w/qw./lab/sem.)	Form of education (I/II/JSM/Course/Training)	Number of hours	Comments
1.					
2.					
3.					
			A total of hours.		

   b) participation of the doctoral student in conducting classes

Lp.	Description of the action (m.in. name of the course, course teacher, role of the doctoral student, etc.)	Number of hours	Comments

[2] delete unnecessary
[3] in accordance with the Regulations of the WAT Doctoral School, the head of the organizational unit in which the doctoral student will carry out professional practice appoints a manager responsible for the implementation of professional practice by the doctoral student in the form of conducting classes or participating in conducting classes
[4] in accordance with the Individual Education Program

1.			
2.			
3.			
	A total of hours.		

6. Information on the reasons for not completing the assumed number of hours of professional practice in the reporting semester and comments on its implementation

……
(date and signature of the doctoral student)

Appendix - *Opinion of the head of the internship on the implementation of the professional practice by a doctoral student of the Doctoral School of the Military University of Technology*

Note from the Dean's Office of the Doctoral School:

Received on .....

……..
(date, signature of the dean's office)

Appendix to the Report on the implementation of the apprenticeship

OPINION OF THE HEAD OF THE PRACTICE
on the implementation of professional practice by a doctoral student of the Doctoral School of the Military University of Technology

1. **Academic year and semester of doctoral student education**

2. **Name and surname of the doctoral student**

3. **./stop. Name and surname of the head of the practice**

4. **Opinion of the head of the practice on the implementation of the internship by the doctoral student**

5. **Evaluation of the internship (incl.)**

……

(date and signature of the head of the practice)

6. **Evaluation of the practice (appendix) by the doctoral student's supervisor – *only* *in the case of implementation of the internship outside WAT5***

……

(date and signature of the promoter)

[5] In the event of a change in the assessment of the practice manager, a justification is required

Case No.: 208544

Decision
Director of the Jarosław Dąbrowski
Doctoral School of the Military

No 56/SDR/2024 of 23 December 2024

on the introduction of the Regulations for the implementation of other forms of education by doctoral students of the Military University of Technology Doctoral School

Pursuant to § 103 section 6 point 11 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 17 section 8 of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the resolution No 28/WAT/2024 of 25 April 2024 on the adoption of "Regulations of the Doctoral School of the Military University of Technology", the following is hereby decided:

§ 1

The Regulations for the Implementation of Other Forms of Education by Doctoral Students of the University of Technology Doctoral School, attached to this Decision, are hereby introduced

§ 2

The decision enters into force on the day of signing.

Dariusz Podbielski, PhD, Eng.
Chief Specialist - Deputy Director of the
Military University of Technology
/ **document signed with a qualified electronic signature** /

Prepared by: Dariusz Podbielski(KSD)
☎ Tel. 261837561, e-mail: dariusz.podbielski@wat.edu.pl

Appendix to the
decision of the Director of the Doctoral School of the
Military University of Technology No. 56/SDR/2024
of 23 December 2024

Rules
implementation of other forms of education by doctoral students Doctoral School Military University of Technology

General assumptions

§ 1

1. The Regulations for the Implementation of Other Forms of Education by Doctoral Students of the Military University of Technology, hereinafter referred to as the "Regulations", specify detailed rules for the implementation and crediting of other forms of education by doctoral students of the Doctoral School of the Military University of Technology.
2. Other forms of education should be understood as postgraduate studies, courses, training, internships (other than teaching or participating in conducting classes) and internships carried out in domestic or foreign universities, institutions, as well as enterprises and
institutions whose scope of activity is related to the subject of the doctoral dissertation.

Objectives of other forms of education

§ 2

1. The purpose of other forms of education is to acquire or expand specialist knowledge and skills and social competences related to the subject of the doctoral dissertation.
2. The learning outcomes for other forms of education that the doctoral student should achieve as a result of the implementation of other forms of education are determined by the doctoral student in the individual curriculum.

Rules for the implementation of other forms of education

§ 3

1. During education at the Doctoral School, a doctoral student may pursue other forms of education referred to in § 1 section 2 in semesters III to VII, subject to paragraph 2.
2. With the consent of the supervisor, other forms of education may also be provided in the first and second semester of education.
3. On the implementation of other forms of education, their hourly and
the assignment of ECTS credits is decided by the supervisor in the individual education program of the doctoral student.
4. Other forms of education can be implemented in a stationary, remote or hybrid form.

§ 4

1. The doctoral student is responsible for preparing for the implementation of other forms of education.
2. At the request of a doctoral student, the WAT Doctoral School may provide support in the field of preparation for the implementation of another form of education, subject to paragraph 3.
3. The Doctoral School of the Military University of Technology does not bear the costs of preparation and participation of the doctoral student in the implementation of other forms of education.
4. In the case of postgraduate studies, courses and training, the doctoral student is subject to the regulations for the implementation of these forms of education.
5. In the case of an internship or internship by a doctoral student, the receiving institution is obliged to appoint a supervisor of the doctoral student responsible for the overall implementation of these forms of education.
6. A doctoral student is obliged to complete all formalities related to the implementation of an internship or internship, including obtaining the required consents, undergoing OHS training and having accident insurance.
7. Additional requirements for the participation of the doctoral student in practice or The traineeship is determined by the institution receiving the doctoral student.
8. After completing the internship or internship, the doctoral student's supervisor is obliged to prepare an opinion. A template of the supervisor's opinion on the implementation of a different form of education by a doctoral student of the WAT Doctoral School is contained in Appendix No. 2 to the Regulations.

Rules for crediting other forms of education

§ 5

1. Other forms of education are subject to credit for the generalized grade: passed/failed (zal/nzal). Credit and entry in the USOS system is made by the supervisor.
2. After completing the implementation of another form of education, the doctoral student submits a report on the implementation of the other form of education to the supervisor. The supervisor may call on the doctoral student to provide additional information about the implementation of another form of education.
3. The template of the report referred to in paragraph 2 is contained in Appendix No. 1 to the Regulations.
4. The report referred to in paragraph 2 shall be accompanied by the doctoral student:
   1) confirmation of the implementation of another form of education, e.g.: certificate, certificate,
      certificate, etc.;
   2) the opinion of the supervisor, in the case of another form of education in the form of an internship or internship, or a certificate of completion of the internship or internship.
5. In the event of failure to pass another form of education, the supervisor sets an additional deadline for credit.
6. In the event of failing to pass another form of education again, the doctoral student may apply in writing to the Director of the Doctoral School for consent to repeat another form of education. The application is accompanied by the opinion of the supervisor and, in the case of an internship or traineeship, the consent of the host institution.
7. The Headteacher may decide to re-implement another form of education in the next semester or semesters or initiate the procedure of removing a doctoral

student from the list of doctoral students.

8. In the case of repeating another form of education of a doctoral student, only one credit date applies. Obtaining a grade failing results in the initiation of

by the Director of the Doctoral School, the procedure of deleting a doctoral student from the list of doctoral students.

§ 6

The report on the implementation of another form of education together with the supervisor's assessment is submitted by the doctoral student to the Dean's Office of the Doctoral School no later than by the end of the semester in which he/she completed (completed) another form of education, regardless of the number of semesters in which it was implemented.

Final provisions

§ 7

In matters not regulated by these regulations, decisions are made by the Director of the Doctoral School of the Military University of Technology.

Appendix No. 1 to the
Regulations for the
Implementation of Other Forms
of Education
by PhD students
WAT Doctoral School

(city, date of application)

REPORT

from the implementation of another form of education

1. Name and surname of the doctoral student
2. Year/semester of doctoral student education – scientific discipline
3. Name of the form of education1
4. Place of implementation of the form of education *(university/institution, faculty – city, country)*
5. Date of implementation of the form of education *(start date – end date)*
6. Stop./. science/profession, name and surname of the doctoral student's supervisor2
7. Settlement of hours:
   1) planned number of hours/ECTS credits3
   2) number of hours completed
8. Detailed scope *(description of activities – goal, tasks, duration, leader, achieved effects, etc.)*
9. Information on the reasons for the non-implementation of planned projects or number of hours and comments on its implementation

……

(date and signature of the doctoral student)

10. Evaluation of the implementation of another form of education (supplement)

[1] name of another form of education included in the individual education programme
[2] the doctoral student's supervisor indicated by the university/institution where the doctoral student will carry out the internship, or
internship
[3] according to the individual curriculum

……

(date and signature of the promoter)

Attachments:

Appendix no. 1 – *confirmation of completion of another form of education (certificate, certificate, etc.)**

Appendix no. 2 – *the opinion of the tutor on the implementation of another form of education only in the form of an internship or*
*internship by a doctoral student of the Doctoral School of the Military University of Technology**

* delete unnecessary

Note from the Dean's Office of the Doctoral School:

Received on .....

……..

(date, signature of the dean's office)

Appendix No. 2 to the
Regulations for the
Implementation of Other Forms
of Education
by PhD students
WAT Doctoral School

OPINION OF THE CAREGIVER

on the implementation of an internship or internship* by a PhD student at the Doctoral School of the Military University of Technology

1. **Name and surname of the doctoral student**

2. **Type of other form of education (internship, internship)**

3. **Date and place of the internship or traineeship** ***(start date – date of end)***

4. **./stop. Name and surname of the doctoral student's supervisor**

5. **Opinion of the doctoral student's supervisor**

6. **Evaluation of the implementation of another form of education (incl./nzal.)**

* delete unnecessary

…….

……

(date and signature of the doctoral student's supervisor)

Scientific Business Card

Title/degree Name and Surname, No ORCID

Prof. Zbigniew Bielecki, Ph.D., D.Sc. Nr ORCID 0000-0002-2777-620X

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Automation, Electronics, Electrical Engineering and Space Technologies (100%)

Area of scientific interest

Detection of optical signals, optical radiation detectors, optoelectronic metrology, low-noise electronic systems and optoelectronic sensors.

Organizational activities

(participation in the work of various bodies, functions performed, in the last 5 years)

Member of the Polish Committee of Optoelectronics and the Polish Photonics Society, as well as of the scientific committees of several national and international conferences. Member of the AEEiTK Discipline Council at the Military University of Technology, member of the Council of the Institute of Microelectronics and Photonics of the Łukasiewicz Research Network, chair of the Science Committee of the AEEiTK Council at the MUT, and member of the Education Committee of the Council of the Institute of Optoelectronics.

Research activities

(participation in programs, projects, grants, method of financing, in the last 5 years)

1. OPUS NCN research project in panel ST7, ID: 351100, titled *"Optoelectronic detection of cancer markers in human exhaled breath"*, University of Warsaw, Military University of Technology (WAT).
2. Project under the strategic research and development program TECHMATSTRATEG, ID: 347510, titled *"Development of structural technology for single-mode cascade lasers for use in optical gas detection systems"*, implemented by a consortium consisting of: Institute of Electron Technology (Leader), Airoptic Sp. z o.o., Wrocław University of Science and Technology – Faculty of Microsystems Electronics and Photonics, Military University of Technology – Institute of Optoelectronics, Wrocław University of Science and Technology – Faculty of Fundamental Problems of Technology, Rzeszów University of Technology.
3. Research project under the Ministry of National Defence Research Grant Program, No. GBMON/13-993/2018/WAT, titled: *"Analysis of the possibility of identifying spectral signatures of selected hazardous materials based on vibrational-rotational spectra using high-resolution UV-FIR absorption spectroscopy and Raman spectroscopy."*
4. Project titled *"Optical information field projection system using a cascade laser"*, submitted to the "Ścieżka dla Mazowsza / 2019" competition, implemented by a consortium: Telesystem-Mesko Sp. z o.o. (Leader), Military University of Technology, Łukasiewicz Research Network – Institute of Electron Technology.
5. Mobile telecommunications system using FSO/RF1 technologies for military applications / RadLIR, Contract Number with NCBiR: DOB-BIO-12-09-010-2023.

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Total number of publications: over 400, number of citations: 1,051, H-index = 19.

1. K. Achtenberg, J. Mikołajczyk, C. Ciofi, G. Scandurra, K. Michalczewski, Z. Bielecki. Low-frequency noise measurements of IR photodetectors with voltage cross correlation system. *Measurement* 183, pp. 1-13, 2021, 109867, https://doi.org/10.1016/j.measurement.2021.109867
2. Prokopiuk, Z. Bielecki, J. Wojtas. Improving the accuracy if the NDIR-based CO_2 sensor for breath analysis. *Metrol. Meas. Syst.* Vol. 28 (2021), No 4, DOI: 10.24425/mms.2021.138578. ISSN 0860-8229
3. J. Wojtas, Z. Bielecki, D. Szabra, J. Mikołajczyk. Laserowa spektroskopia absorpcyjna z wykorzystaniem kwantowych laserów kaskadowych do detekcji amoniaku w zakresie długofalowym poczerwieni. *Przegląd Elektrotechniczny*. R. 97, Nr 10, 2021. ISSN 0033-2097.
4. M. Winkowski, J. Mijas, T. Stacewicz, Z. Bielecki, J. Wojtas. Optoelectronic detection of disease biomarkers in air exhaled from human lungs. *Acta Phys. Pol. A*, No 3, Vol. 139, pp. 231-235, 2021.
5. Z. Bielecki, K. Achtenberg, M. Kopytko, J. Mikołajczyk, J. Wojtas, A. Rogalski. Review of photodetectors characterization methods. *Bulletin of the Polish Academy of Sciences. Technical Sciences*, Vol. 70(2), 2022, Article number: e140534, DOI: 10.24425/bpasts.2022.140534
6. K. Achtenberg, J. Mikołajczyk, C. Ciofi, G. Scandurra, Z. Bielecki Transformer-based low frequency noise measurement system for the investigation of infrared detectors' noise. *Measurement* 190 (2022) 110657. https://doi.org/10.1016/j.measurement.2021.110657
7. G. Scandurra, K. Achtenberg, Z. Bielecki, J. Mikołajczyk, C. Ciofi. On the Use of Supercapacitors for DC Blocking in Transformer-Coupled Voltage Amplifiers for Low-Frequency Noise Measurements. *Electronics* 2022, *11*, 2011. https://doi.org/10.3390/electronics11132011.
8. K. Achtenberg , J. Mikołajczyk, Z. Bielecki. Application of cross-correlation-based transimpedance amplifier in InAs and InAsSb IR detectors noise measurements. *Opto-Electronics Review* 30 (2022) e141126. https://doi.org/10.24425/opelre. 2022.141126.
9. K. Achtenberg, J. Mikołajczyk, Z. Bielecki. Two-Channel Detecting Sensor with Signal Cross-Correlation for FTIR Instruments. *Sensors* 2022, *22*, 8919. https://doi.org/10.3390/s22228919
10. A. Rogalski, Z. Bielecki, J. Mikołajczyk, J. Wojtas. Ultraviolet Photodetectors: From Photocathodes to Low-Dimensional Solids. *Sensors* 2023, 23, 4452. https://doi.org/10.3390/s23094452
11. K. Achtenberg, G. Scandurra, J. Mikołajczyk, C. Ciofi, Z. Bielecki. Transimpedance Amplifier for Noise Measurements in Low-Resistance IR Photodetectors. *Appl. Sci*. 2023, 13, 9964. https://doi.org/10.3390/app13179964
12. K. Achtenberg, W. Gawron, Z. Bielecki. Low-frequency noise and impedance measurements in Auger suppressed LWIR N+p(π)P+n+ HgCdTe detector. *Infrared Physics & Technology* 137 (2024) 105110 https://doi.org/10.1016/j.infrared.2023.105110
13. K. Achtenberg, J. Mikołajczyk, Z. Bielecki. IR detection module with integrated real-time FIR filter implemented in FPGA. *Int. Journal of Electronics and Telecommunications*, 2024, Vol. 70, No. 1, PP. 175-182. doi:10.24425/ijet.2024.149528
14. Z. Bielecki, J. Mikolajczyk, J. Wojtas. A Review of Thermal Detectors of THz Radiation Operated at Room Temperature. *Sensors* 2024, 24, 6784. https://doi.org/10.3390/s24216784
15. K. Achtenberg, R. Szplet, Z. Bielecki. Advanced, Real-Time Programmable FPGA-Based Digital Filtering Unit for IR Detection Modules. *Electronics* 2024, 13, 4449. https://doi.org/10.3390/
16. K. Achtenberg, K. Majkowycz, P. Martyniuk, Z. Bielecki. Low-frequency noise and deep-level transient spectroscopy in LWIR Auger-suppressed Hg_{1-x} Cd_xTe heterostructure detector. *Optics Express*, Vol. 32, No. 25, 45096, 2024. https://doi.org/10.1364/OE.540281
17. K. Achtenberg, Z. Bielecki. Comparative Analysis of the Selected Photoreceiver Input Stages in Terms of Noise. *Sensors*. 2025; 25(5):1359. https://doi.org/10.3390/s25051359
18. J. Mikolajczyk, W. Gawron, D. Szabra, A. Prokopiuk, Z. Bielecki. Advanced Beam Detection for Free-Space Optics Operating in the Mid-Infrared Spectra. *Sensors*. 2025; 25(19):6112. https://doi.org/10.3390/s25196112

Textbooks and monographs:

1. A. Rogalski, Z. Bielecki. *Detekcja sygnałów optycznych*. PWN 2020. ISBN 978-83-01-20996-4.
2. A. Rogalski, Z. Bielecki. *Detection of optical signals*. CRC Press. Taylor & Francis Group. 2022 r. ISBN 9781032059488
3. Współczesne systemy łączności i elektronika w obszarze zagrożeń militarnych. Praca zbiorowa pod red. naukową M. Marczyka, N. Świętochowskiego, M. Błachuta. Rozdział autorstwa: J. Mikołajczyk, Z. Bielecki, D. Szabra, A. Prokopiuk, B. Pietrzyk, K. Achtenberg, J. Wojtas. Bezprzewodowa łączność optyczna. 2024r.
4. Z. Bielecki, M. Kopytko, J. Wojtas. *Urządzenia i systemy optoelektroniczne*. PWN 2025 (w druku).

Education activities

(modules, average number of hours of classes, in the last 5 years)

- Detection of optical signals
- Detectors of optical radiation
- Optoelectronics
- Optoelectronic Devices and Systems

Average number of teaching hours – over 100% of the professor's standard teaching load.

Achievements

(awards, distinctions, patents in the last 5 years)

One patent

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors – 1.
Number of reviews: PhD theses – 7, habilitation proceedings – 9, opinion in professorial proceedings – 4.

Contact

Place of work: building no./room no.: 100/215B

Tel.: 601-28-42-23

Email: Zbigniew.bielecki@wat.edu.pl

Scientific Business Card

Title/degree Name and Surname, No ORCID

Prof. Andrzej Dobrowolski, D.Sc., Ph.D., 0000-0002-0593-158X

Position, management function

Scientific discipline represented (scientific disciplines %)

Automation, Electronics, Electrical Engineering and Space Technologies

Area of scientific interest

Signal processing, artificial intelligence, multidimensional speech signal analysis, biomedical signal analysis, biometrics, electronic systems, electromagnetic weapons

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

- ✓ Vice-Rector for Research, Military University of Technology (WAT), 2020–2024
- ✓ Dean of the Faculty of Electronics, Military University of Technology (WAT), 2016–2020
- ✓ Member of the Council of Companies in the Electrotechnical and Power Industry Association (SEP), 2017–2020
- ✓ Member of the Electronics and Telecommunications Committee, Polish Academy of Sciences (PAN), 2020–2023
- ✓ Chairman of the Scientific Council of the WAT Bulletin, 2020–2024
- ✓ Member of the Editorial Board of the journal *Electronics – Constructions, Technologies, Applications*, 2019–present
- ✓ Member of the Program Committee of the 2nd National Metrology Conference (KKM), 2025
- ✓ Member of the Program Committee of the Scientific and Technical Conference *Security Engineering – Protection Against Extraordinary Threats "EKOMILITARIS"*, editions: 2025, 2024, 2023, 2022, 2021
- ✓ Member of the Program Committee of the Conference *Electronics, Telecommunications and Power Engineering of Students and Young Scientists "SECON"*, editions: 2025, 2024, 2023, 2022, 2021
- ✓ Member of the Program Committee of the Conference *Unmanned Autonomous Systems*, editions: 2024, 2023, 2022
- ✓ Member of the Program Committee of the Scientific and Technical Conference *Electronic Warfare and Reconnaissance Systems (KNTWRE)*, 2024
- ✓ Member of the Program Committee of the Conference *Into the Future with the Military University of Technology! The Educational Potential of a Military University*, 2023

- ✓ Co-chair of the Program Committee of the *15th International Conference on Advanced Trends in Radioelectronics, Telecommunications and Computer Engineering (TCSET)*, 2020
- ✓ Member of the Program Committee of the *Multiconference of the National Telecommunications and Radiocommunications Community (KKRRiT and KSTiT)*, 2020

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

Participation as a task group leader in grant no. DOB-SZAFIR/09/B/006/01/2021 under the competition 1/SZAFIR/2020 (*Scientific Research and Development Projects for National Defense and Security*) entitled *Decision Support System for Medical Evacuation Based on Monitoring of Soldiers' Vital Parameters and Enhanced Situational Awareness.*

Project start date - end date: June 1, 2021 - May 31, 2024

Project funded by: National Centre for Research and Development (NCBR)

Total project cost: 6,953,022.00 PLN

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

- ✓ Number of publications: 235
- ✓ h-index (Scopus citations): 11
- ✓ h-index (Web of Science citations): 10
- ✓ h-index (Google Scholar): 14
- ✓ Total Impact Factor (IF): 103.126
- ✓ Total SNIP: 60.871
- ✓ Total CiteScore: 200.87
- ✓ Total ministerial score: 2,826

Most important publications in the last 5 years:

1. P. Stasiakiewicz, A. Dobrowolski, T. Targowski, N. Gałązka-Świderek, T. Sadura-Sieklucka, K. Majka, A. Skoczylas, W. Lejkowski, R. Olszewski, *Automatic classification of normal and sick patients with crackles using wavelet packet decomposition and support vector machine*, Biomedical Signal Processing and Control, vol. 67, 2021, pp. 1-13, DOI: 10.1016/j.bspc.2021.102521, [*IF* = 3,137, 140 pkt.]
2. T. Sondej, I. Jannasz, K. Sieczkowski, A. Dobrowolski, K. Obiała, T. Targowski, R. Olszewski, *Validation of a new device for photoplethysmographic measurement of multi-site arterial pulse wave velocity*, Biocybernetics and Biomedical Engineering, vol. 41, 2021, pp. 1664-1684, DOI: 10.1016/j.bbe.2021.11.001, [*IF* = 4,314, 140 pkt.]
3. K. Kamiński, A. Dobrowolski, *Automatic speaker recognition system based on gaussian mixture models, cepstral analysis and genetic selection of distinctive*

features, Sensors 2022, 22(23), 9370; https://doi.org/10.3390/s22239370, [100 pkt.]

4. P. Łubkowski, J. Krygier, T. Sondej, A. Dobrowolski, Ł. Apiecionek, W. Znaniecki, P. Oskwarek, *Decision support system proposal for medical evacuations in military operations,* Sensors, 2023, 23, 5144, https://doi.org/10.3390/s23115144, [100 pkt.]
5. I. Jannasz, T. Sondej, T. Targowski, M. Mańczak, K. Obiała, A. Dobrowolski, R. Olszewski, *Relationship between the central and regional pulse wave velocity in the assessment of arterial stiffness depending on gender in the geriatric population*, Sensors, 2023, 23, 5823, https://doi.org/10.3390/s23135823, [100 pkt.]
6. K. Kamiński, A. Dobrowolski, Z. Piotrowski, P. Ścibiorek, *Enhancing Web Application Security: Advanced Biometric Voice Verification for Two-Factor Authentication*, Electronics, 2023, 12, 3791, https://doi.org/10.3390/electronics12183791, [140 pkt.]
7. D. Mały, A. Dobrowolski, *Behavioral features of the speech signal as part of improving the effectiveness of the automatic speaker recognition system*, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, vol. 4, 2023, pp. 26-34, DOI: 10.37105/iboa.187, [140 pkt.]
8. A. Dobrowolski, P. Oskwarek, S. Rokicki, P. Wiktorzak, P. Łubkowski, P. Murawski, *Survival probability function as a supporting element in automated triage system on the battlefield*, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, vol. 4, 2023, pp. 46-59, DOI: 10.37105/iboa.188, [140 pkt.]
9. J. Krygier, P. Łubkowski, K. Maślanka, A. Dobrowolski, T. Mrozek, W. Znaniecki, P. Oskwarek, *Smart medical evacuation support system for the military*, Sensors, 2024, 24, 4581. https://doi.org/10.3390/s24144581, [100 pkt.]
10. K. Majka, W. Lejkowski, A. Pepłoński, T. Grycewicz, A. Krupienicz, A. Dobrowolski, R. Olszewski, *The use of an electronic stethoscope with dedicated software for cardiovascular screening of patients prepared for hip replacement*, Academia Journal of Scientific Research, 8(6), pp. 207-217, 2020, DOI: 10.15413/ajsr.2020.0110, [5 pkt.]
11. D. Mały, A. Dobrowolski, *Ekstrakcja danych numerycznych z wykresów słuchowych potencjałów wywołanych,* Elektronika: konstrukcje, technologie, zastosowania, nr 3/2020, s. 4-7, [5 pkt.]
12. M. Bojsza, A. Dobrowolski, *Ocena wpływu szumów i zakłóceń na skuteczność automatycznego systemu rozpoznawania mówcy w warunkach różnorodności językowej,* Elektronika: konstrukcje, technologie, zastosowania, nr 6/2021, s. 27-31, [20 pkt.]
13. A. Dobrowolski, P. Oskwarek, S. Rokicki, P. Wiktorzak, P. Łubkowski, P. Murawski, *System automatycznego wsparcia triażu wykorzystujący algorytm drzewa decyzyjnego i funkcję szans przeżycia*, Biuletyn WAT 2022; 71 (3): 31-67, DOI: 10.5604/01.3001.0053.6743, [20 pkt.]
14. K. Sieczkowski, A. Dobrowolski, T. Sondej, R. Olszewski, *Wyznaczanie czasu propagacji fali tętna w oparciu o sygnały EKG i PPG*, Wyroby medyczne, 2024, 3, s. 33-38 [5 pkt.]

15. J. Krygier, P. Łubkowski, T. Sondej, A. Dobrowolski, K. Maślanka, *Inteligentny system wsparcia ewakuacji medycznej dla służb mundurowych*, Przegląd Telekomunikacyjny – Wiadomości Telekomunikacyjne, nr 6/2024, pp. 12-19, DOI: 10.15199/59.2024.6.2, [20 pkt.]

Education activities
(modules, average number of hours of classes, in the last 5 years)

Average number of teaching hours in the last 5 years: 265 hours annually

Taught subjects (Bachelor's and Master's level):

- ✓ Electronics
- ✓ Computer Analysis of Electronic Circuits
- ✓ Computational and Simulation Techniques
- ✓ Analog Circuits
- ✓ Analog Techniques
- ✓ Contemporary Engineering of Analog Electronics
- ✓ Measurement and Analysis of Biosignals
- ✓ Measurements in Medicine

Achievements
(awards, distinctions, patents in the last 5 years)

- ✓ Team Award of the Rector of the Military University of Technology for developing a decision support system for medical evacuation based on monitoring soldier's vital parameters and enhanced situational awareness, 2025
- ✓ Gold Medal "For Long Service," 2022
- ✓ Gold Cross of Merit, 2021
- ✓ Medal of the 100th Anniversary of the Association of Polish Electrical Engineers (SEP), 2020

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted PhD graduates:	4 (total 8)
Number of doctoral reviews conducted:	3
Number of reviews in habilitation procedures:	2
Number of opinions in professorial procedures:	2

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Piotr Kaniewski, Ph.D. Eng., Habilitated, 0000-0002-3873-2894

Position, management function

Associate Professor

Scientific discipline represented (scientific disciplines %)

Automation, Electronics, Electrical Engineering and Space Technologies (100%)

Area of scientific interest

Research interests include navigation systems for special purposes, such as supporting Synthetic Aperture Radar (SAR) and Ground Penetrating Radar (GPR), distributed estimation algorithms for swarms of Unmanned Aerial Vehicles (UAVs), as well as navigation systems for GNSS denied environments. The research is also oriented towards the integration of inertial, visual, and radar methods within data fusion frameworks for precise localization and mapping (SLAM).

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Participation in various bodies:

1. Associate Editor of the journal *Metrology and Measurement Systems* (Polish Academy of Sciences, ISSN 2080-9050), 2020–present.
2. Member of the Editorial Board of the journal *Radioelectronics and Communications Systems* (ISSN 0735-2727), Ukraine, 2018–present.
3. Vice-Chairman of the Program Committee of the International Scientific Conference *on Advanced Trends in Radioelectronics, Telecommunications and Computer Engineering* (TCSET 2022), Ukraine.
4. Member of the Program Committee of the International Scientific Conference *on Advanced Trends in Radioelectronics, Telecommunications and Computer Engineering* (TCSET 2024, 2026), Ukraine.
5. Vice-Chairman of the Program Committee of the conference *Electronic Warfare and Reconnaissance Systems* (KNTWRE 2024).
6. Member of the Program Committee of the international scientific conference *Signal Processing Symposium* (SPSympo 2021, 2023, 2025).
7. Member of the Program Committee of the international scientific conference *International Radar Symposium* (IRS 2022, 2024).
8. Member of the Program Committee of the international scientific conference *The Role of Navigation in Securing Human Activities at Sea* (NAVSUP 2022, 2026).
9. Member of the Program Committee of the scientific and technical conference KNT Radiolokacji (2021, 2023).
10. Member of the Program Committee of the *National Metrology Conference* (KKM 2021).

11. Member of the Program Committee of the *Conference on Electronics, Telecommunications and Power Engineering of Students and Young Scientists* (SECON 2022–2025).

Functions held:

1. Director of the Institute of Radioelectronics, Faculty of Electronics, Military University of Technology, 2012–2024.
2. Member of the Science Committee of the Senate of the Military University of Technology, terms 2020–2024 and 2024–2028.
3. Chairman of the Personnel Committee of the Scientific Discipline Council of Automation, Electronics, Electrical Engineering and Space Technologies (AEEiTK), term 2024–2028.
4. Vice-Chairman of the Personnel Committee of the Scientific Discipline Council of Automation, Electronics, Electrical Engineering and Space Technologies (AEEiTK), term 2020–2024.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

"Intelligent, Integrated System for Localization, Preliminary Assessment, and Medical Assistance for Casualties on the Battlefield Using Geoinformation and Biomedical Sensors" (MILGEOMED), Head of the Research Team, National Centre for Research and Development (NCBR), Project No. DOB-SZAFIR/09/A/010/01/2021, 2021–2025.

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Total number of publications: 210

h-index (Web of Science): 9
h-index (Scopus): 10

Selected publications from the last 5 years:

[1] P. Słowak, T. Kraszewski, and **P. Kaniewski**, "Handheld Ground-Penetrating Radar Antenna Position Estimation Using Factor Graphs," *Sensors*, vol. 25, no. 11, p. 3275, 2025, doi: 10.3390/s25113275.

[2] P. Smagowski and **P. Kaniewski**, "Algorithm for Estimating Ballistic Object Trajectories Using an Electro-Optical Tracking System," *Metrology and Measurement Systems*, vol. 32, no. 2, pp. 1–14, 2025, doi: 10.24425/mms.2025.154667.

[3] T. Kraszewski, J. Panasiuk, P. Słowak, and **P. Kaniewski**, "Testing Positioning System for Ground Penetrating Radar Using Multi-Degree-of-Freedom Industrial Robot," *Metrology and Measurement Systems*, vol. 32, no. 3, pp. 1–15, 2025, doi: 10.24425/mms.2025.154681.

[4] P. Pasek and **P. Kaniewski**, "Energy-Efficient Distributed Estimation Algorithm for Wireless Sensor Networks Based on Covariance Intersection with Eigendecomposition," *Metrology and Measurement Systems*, vol. 31, no. 3, pp. 465–480, 2024, doi: 10.24425/mms.2024.150290.

[5] **P. Kaniewski** and T. Kraszewski, "Estimation of Handheld Ground-Penetrating Radar Antenna Position with Pendulum-Model-Based Extended Kalman Filter," *Remote Sensing*, vol. 15, no. 3, p. 741, 2023, doi: 10.3390/rs15030741.

[6] P. Słowak and **P. Kaniewski**, “Homography Augmented Particle Filter SLAM,” *Metrology and Measurement Systems*, vol. 30, no. 3, pp. 423–439, 2023.
[7] P. Słowak and **P. Kaniewski**, “Stratified Particle Filter Monocular SLAM,” *Remote Sensing*, vol. 13, no. 16, p. 3233, 2021, doi: 10.3390/rs13163233.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Modules:

1. Data Processing Algorithms
2. Navigation Data Processing
3. Data Processing in Radiolocation Systems
4. Satellite Navigation Systems
5. Integrated Navigation Systems
6. Target Tracking
7. Fundamentals of Modulation and Detection
8. Radio Technology

Average number of hours of classes: 319

Achievements
(awards, distinctions, patents in the last 5 years)

Silver Medal “For Merits to the Military University of Technology”, 2021.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors: 3

Number of reviews – doctoral students: 2

Number of reviews – in habilitation proceedings: –

Opinions in professorial proceedings: –

Contact

Place of work: building no./room no.: 61/25

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Scientific Business Card

Title/degree Name and Surname, No ORCID

DSc. engineer Jaroslaw Mlynczak, Associate professor

Position, management function

University professor, Head of Department, Head of Accredited Research Laboratory

Scientific discipline represented (scientific disciplines %)

Automation, Electronics, Electrical Engineering and Space Technologies (100%)

Area of scientific interest

Lasers, Laser safety, Laser detection of biological and chemical agents

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Chairman of the Organizing Committee of the 9th Metrology Congress

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Project under the HORIZON 2020 program, call: H2020-SU-SEC-2018-2019-2020, No. 883116, titled “Real-time on-site forensic tracE qualification (RISEN)”, initiated in 2020, role: project manager implemented by the Military University of Technology, funding body: European Commission, end date: December 31, 2024.
2. Real-time on-scene qualification of forensic trace evidence – GRANTS for GRANTS III. Project Manager at Military University of Technology, start date: July 15, 2020, end date: July 17, 2020.
3. Real-time qualification of trace forensic evidence at the scene - PREMIA ON THE HORIZON 2. Project Manager at Military University of Technology, start date: August 18, 2020, ongoing
4. Programme: European Defence Fund (EDF), ID: EDF-2021-PROTMOB-D-SS, Augmented Capability for High-End Soldiers, Proposal number: 101074945. Project Manager at Military University of Technology, start date: December 1, 2022, ongoing

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Number of publications: 78,
Hirsch index: 16

1. M. Kaliszewski, M. Włodarski, **J. Młyńczak**, K. Kopczyński, Comparison of Low-Cost Particulate Matter Sensors for Indoor Air Monitoring during COVID-19 Lockdown, *Sensors,* vol. *20*, 7290, 2020, DOI: 10.3390/s20247290
2. T. Karpate, I. Kujawa, R. Kasztelanic, R. Stępień, J. Kisielewski, K. Kopczyński, **J. Mlynczak**, Integration of alumina-phosphate glass with cobalt-doped magnesium aluminate structure using a hot embossing technique for microlaser development, Applied Optics, vol. 60, No. 5, pp. 1456-1462, 2021, DOI: 10.1364/AO.414301.
3. **J. Mlynczak**, Laser toys fail to comply with safety standards –case study based on laser product classification, Adv. Opt. Techn., vol. 10, No. 2, pp. 139-142, 2021, DOI: 10.1515/aot-2020-0072.

4. **J. Mlynczak**, M. Zyskowski, Investigation of the Impact of the Pumping Beam Waist Size and Position on the Efficiency of YVO4/Nd : YVO4/YVO4 Laser Generation, International Journal of Optics, vol. 2021, 2021, DOI: 10.1155/2021/5451467.
5. **J. Mlynczak**, K. Kopczynski, M. Kaliszewski, M. Wlodarski, Estimation of nominal ocular hazard distance and nominal ocular dazzle distance for multibeam laser radiation, Applied Optics, vol. 60, No. 22, pp. 6414-6421, 2021, DOI: 10.1364/AO.431490.
6. M. Ł. Kowalski, N. Pałka, **J Młyńczak**, M. Karol, E. Czerwinska, M. Zyczkowski, W. Ciurapinski, Z. Zawadzki, S. Brawata, Detection of Inflatable Boats and People in Thermal Infrared with Deep Learning Methods, Sensors, vol. 21, No. 16, 5330, 2021, DOI: 10.3390/s21165330.
7. M. Kaliszewski, M. Włodarski, **J. Młyńczak**, B. Jankiewicz, L. Auer, B. Bartosewicz, M. Liszewska, B. Budner, M. Szala, B. Schneider, G. Povoden K. Kopczyński, The Multi-Gas Sensor for Remote UAV and UGV Missions—Development and Tests, Sensors, vol. 21, 7608, 2021, DOI: 10.3390/s21227608
8. **J. Mlynczak**, Calculation and analysis of laser hazard distances in navigable airspace for multi-beam visible CW laser radiation, Adv. Opt. Techn., vol. 11, No. 1-2, pp. 33-46, 2022, IF: 1.8, DOI: doi.org/10.1515/aot-2022-0004
9. T. K. Das, M. Jesionek, M. Kępińska, M. Nowak, M. Kotyczka-Morańska, M. Zubko, **J. Młyńczak** and K. Kopczyński, $SbI_3 \bullet 3S_8$: A Novel Promising Inorganic Adducts Crystal for Second Harmonic Generation, Materials, vol. 16, 1105, pp. 1-12, 2023, DOI: doi.org/10.3390/ma16031105.
10. **J. Mlynczak**, Analysis of the impact of the atmospheric attenuation and the measurement uncertainties on the laser hazard distances in navigable airspace for visible cw laser radiation, Metrology and Measurement Systems, Vol. 30, No. 2, pp. 1-13, 2023, DOI: 10.24425/mms.2023.144869
11. J. Mlynczak, Measuring the low divergent luminous flux emitted by LED torch lamps using a simple detector and a spectrometer as an alternative to an integrating sphere, Measurement, vol. 241, 115725, 2025, DOI: 10.1016/j.measurement.2024.115725

Education activities
(modules, average number of hours of classes, in the last 5 years)

1. Laser Radiation Metrology
2. Measurements of Basic Laser Radiation Parameters
3. Optoelectronic Measuring Devices

Approx. 90 educ. hours.

Achievements
(awards, distinctions, patents in the last 5 years)

1. Winner of the "Leaders in University Management" program, study visit to the Technical University of Munich from October 15-21, 2023.

2. WAT Commemorative Badge, Decision of the Rector of WAT No. 422/RKR/2022 of November 22, 2022.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

-

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

prof. Norbert PAŁKA, 0000-0002-1931-876X

Position, management function

Optoelectronic System Department Head

Scientific discipline represented (scientific disciplines %)

automation, electronics, electrical engineering and space technologies (AEETK): 100%

Area of scientific interest

Terehertz technology, security systems

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

1. Chairman of the Council - Łukasiewicz Research Network, Institute of Microelectronics and Photonics
2. Member of the Senate of the Military University of Technology (WAT)
3. Member of the Disciplinary Council of the AEETK WAT
4. Member of the Education Council of the IOE WAT

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. „Perymetria na obszarach podmokłych/przybrzeżnych/rzekach", NCBR: DOB-BIO9/25/01/2018, 2018-2021, kierownik projektu.
2. „Strategy-Oriented anaLysis Of the Market fOrces in EU defeNce," Europejska Agencja Obrony: 831739, 2019-2021, kierownik projektu w WAT.
3. „Opracowanie i badanie właściwości materiałów ceramicznych o niskiej przenikalności elektrycznej przeznaczonych na podłoża LTCC i ULTCC", NCN (OPUS): UMO-2019/35/B/ST5/02674, 2021-2023, kierownik projektu w WAT.
4. „Opracowanie prototypu zaawansowanego technologicznie systemu informatycznego umożliwiającego zautomatyzowanie procesu analizy obrazów uzyskanych z ukrytych urządzeń optoelektronicznych", NCBR: DOB-BIO11/02/06/2020, 2021-2023, kierownik projektu w WAT.
5. „Nowatorskie metody diagnostyki terahercowej w wybranych kluczowych zastosowaniach w wojsku i bezpieczeństwie", NCBR: DOB-SZAFIR/02/A/001/01/2020, 2021-2024, kierownik projektu w WAT.
6. „PolFEL – Polski Laser na Swobodnych Elektronach", POIR: 04.02.00-00-B002/18-00, 2019-2025, główny wykonawca.
7. „Laserowy system wykrywania i śledzenia nisko latających obiektów", NCBR: DOB-BIO9/21/01/2018, 2018-2021, wykonawca.
8. „robusT Risk basEd Screening and alert System for PASSengers and luggage", Komisja Europejska (H2020): 787120, 2018-2021, wykonawca.
9. „Fighting Crime and TerroRism with an IoT-enabled Autonomous Platform based on an Ecosystem of Advanced IntelligEnce, Operations, and InveStigation Technologies," Komisja Europejska (H2020): 833464, 2019-2022, wykonawca.
10. „Detecting Document frauD and iDentity on the fly", Komisja Europejska (H2020): 833704, 2019-2022, wykonawca.
11. „Traceability for electrical measurements at millimetre-wave and terahertz frequencies for communications", EMPIR: 18SIB09, 2019-2022, wykonawca.

12. „Opracowanie technologii nieniszczącego diagnozowania gazociągów w oparciu o magnetyczną metodę bezkontaktową i sensory zintegrowane z wykorzystaniem algorytmów uczenia maszynowego", POIR: 04.01.01-00-0052/18, 2019-2022, główny wykonawca.
13. „Technology Foresight on Biometrics for the Future of Travel", Europejska Agencja Straży Granicznej i Przybrzeżnej (European Border and Coast Guard Agency, Frontex), 2021, wykonawca.
14. „Ceramika współwypalana w ultraniskiej temperaturze dla elektronicznych układów szóstej generacji (6G)", NCBR: M-Era.Net2/2020/1/2021, 2021-2024, wykonawca.

„Building a common understanding of the effectiveness of counter-UAS solutions", Komisja Europejska (H2020): 101034655, 2021-2024, wykonawca.

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

1. E. Pliński, N. Pałka, S. Plińska, „Applications of the Terahertz ATR Spectroscopy to Pharmacology", **Acta Poloniae Pharmaceutica - Drug Research** 78(4), 467-474 (2021). IF_{2021}=0,555, punkty MNiSW=100.
2. K. Zeranska-Chudek, A. Siemion, N. Pałka, A. Mdarhri, I. Elaboudi, C. Brosseau, M. Zdrojek, „Terahertz Shielding Properties of Carbon Black Based Polymer Nanocomposites", **Materials** 14(4), 835 (2021). IF_{2021}=3,748, punkty MNiSW=140.
3. D. Szwagierczak, B. Synkiewicz-Musialska, J. Kulawik, N. Pałka, „LTCC and Bulk Zn4B6O13–Zn2SiO4 Composites for Submillimeter Wave Applications", **Materials**, 14(4), 1014 (2021). IF_{2021}=3,748, punkty MNiSW=140.
4. M. Mączka, M. Ptak, M. Trzebiatowska, E. Kucharska, J. Hanuza, N. Pałka, E. Czerwińska, „THz, Raman, IR and DFT studies of noncentrosymmetric metal dicyanamide frameworks comprising benzyltrimethylammonium cations", **Spectrochimica Acta Part A** 251, 119416 (2021). IF_{2021}=4,831, punkty MNiSW=140. h
5. Grudzień, M. Kowalski, N. Pałka, „Thermal Face Verification through Identification", **Sensors** 21(9), 3301 (2021). IF_{2021}=3,847, punkty MNiSW=100.
6. D. Szwagierczak, B. Synkiewicz-Musialska, J. Kulawik, N. Pałka, „Sintering, Microstructure, and Dielectric Properties of Copper Borates for High Frequency LTCC Applications", **Materials** 14 (14), 4017 (2021). IF_{2021}=3,748, punkty MNiSW=140.
7. B. Synkiewicz-Musialska, D. Szwagierczak, J. Kulawik, N. Pałka, P. Piasecki, „Structural, Thermal and Dielectric Properties of Low Dielectric Permittivity Cordierite-Mullite-Glass Substrates at Terahertz Frequencies", **Materials** 14(14), 4030 (2021) IF2021=3,748, punkty MNiSW=140.
8. M. Kowalski, N. Pałka, J. Młyńczak, M. Karol, E. Czerwińska, M. Życzkowski, W. Ciurapiński, Z. Zawadzki, S. Brawata, „Detection of Inflatable Boats and People in Thermal Infrared with Deep Learning Methods", **Sensors** 21(16), 5330 (2021). IF_{2021}=3,847, punkty MNiSW=100.
9. K. Żerańska, K. Filak, K. Wilczyński, A. Siemion, N. Pałka, K. Godziszewski, Y. Yashchyshyn, M. Zdrojek, „Graphene-Based Thermoplastic Composites as Extremely Broadband and Frequency-Dependent EMI Absorbers for Multifunctional Applications", **ACS Applied Electronic Materials** 4(9), 4463-4470 (2022). IF_{2022}=4,7, punkty MNiSW=20.
10. N. Pałka, M. Maciejewski, K. Kamiński, M. Piszczek, P. Zagrajek, E. Czerwińska, M.Walczakowski, K. Dragan, P. Synaszko, W. Świderski, "Fast THz-TDS Reflection Imaging with ECOPS—Point-by-Point versus Line-by-Line Scanning", **Sensors** 22(22), 8813 (2022). IF_{2022}=3,9, punkty MNiSW=100.
11. D. Szwagierczak, B. Synkiewicz-Musialska, J. Kulawik, E. Czerwińska, N. Pałka, „Novel copper borate ceramics with lithium-based sintering aids for LTCC terahertz applications", **Journal of Materials Chemistry C** 11, 1863–1871 (2023). IF_{2022}=6,4, punkty MNiSW=140.
12. D. Szwagierczak, B. Synkiewicz-Musialska, J. Kulawik, E. Czerwińska, N. Pałka, „Ultra-low temperature cofired ceramics based on Li2WO4 as perspective substrate materials for terahertz frequencies", **Journal of Advanced Ceramics** 12, 526–538 (2023). IF_{2022}=16,9, punkty MNiSW=140.
13. M. Walczakowski, M. Maciejewski, N. Pałka, „Remote Spectral Identification in the THz Band with Reflection Spectroscopy in an Open Atmosphere", **Applied Sciences** 13, 7788 (2023). IF_{2022} =2,7, punkty MNiSW=100.
14. N. Pałka, B. Synkiewicz-Musialska, D. Szwagierczak, E. Czerwińska, „Terahertz spectra of selected low-temperature cofired ceramics: A comparative study", **Materials Research Bulletin** 168, 112484 (2023). IF_{2022}=5,4, punkty MNiSW=100.

15. N. Pałka, K. Kamiński, M. Maciejewski, K. Dragan, P. Synaszko, „Automatic histogram-based defect detection in glass fibre reinforced polymer composites using terahertz time-domain spectroscopy reflection imaging", **Optics and Lasers in Engineering** 174, 107959 (2024). IF_{2022}=4,6, punkty MNiSW=140.
16. N. Pałka, K. Kamiński, M. Maciejewski, D. Pacek, W. Świderski, „Terahertz nondestructive testing of alumina-based ceramic ballistic protection armor", **Infrared Physics & Technology** 137, 105163 (2024), IF_{2022}=3,3, punkty MNiSW=100.
17. M. Maciejewski, K. Kamiński, N. Pałka, "A Hardware Encoder-Based Synchronization Method for a Fast Terahertz TDS Imaging System Based on the ECOPS Scheme", **Sensors** 24(6), 1806 (2024), IF2022=3,9, punkty MNiSW=100.
18. P. Komorowski, P. Zagrajek, M. Piszczek, E. Czerwińska, N. Pałka, „*Wavelength measurement of narrowband terahertz radiation using a diffraction grating", **Measurement** 230, 114513 (2024)*. IF_{2022}=5,6, punkty MNiSW=200.
19. N. Pałka, K. Kamiński, M. Maciejewski, D. Powała, A. Orzechowski, W. Świderski, „Non-destructive evaluation of artillery combustible cartridge case using terahertz radiation", **Measurement** 233, 11477 (2024), IF_{2022}=5,6, punkty MNiSW=200.
20. M Białek, Y Todorov, K Stelmaszczyk, D Szwagierczak, B. Synkiewicz-Musialska, J. Kulawik, N. Pałka, M. Potemski, W. Knap, "Hybridization of Terahertz Phonons and Magnons in Disparate and Spatially-Separated Material Specimens", **Advanced Functional Materials** 35 (9), 2416037. IF_{2022}=17,6, punkty MNiSW=200.

Education activities

(modules, average number of hours of classes, in the last 5 years)

1. Terahertz technique
2. Terahertz systems
3. Basics of terahertz technologyok.

~100 h/year

Achievements

(awards, distinctions, patents in the last 5 years)

Award of the Rector of the Military University of Technology for lifetime achievements, 14/10/2025

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted PhDs: 2

Number of PhD student reviews: 3

In habilitation proceedings: 1

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

prof. Ryszard Szplet, 0000-0003-3085-013X

Position, management function

professor

Scientific discipline represented (scientific disciplines %)

automation, electronics, electrical engineering and space technologies (100%)

Area of scientific interest

Digital technology. Theory of logic circuits. Digital integrated circuits, particularly programmable (FPGA) and specialized (ASIC) circuits. Methods and tools for designing digital systems. Hardware description languages. Methods and techniques for precise time and frequency metrology.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

- Dean of the Faculty of Electronics, Military University of Technology (2020-2024)

- Editor-in-Chief of the Polish Academy of Sciences Journal indexed in the Journal Citation Reports database - Metrology and Measurement Systems (since 2020)

- Member of the Committee on Metrology and Scientific Equipment, Polish Academy of Sciences (since 2016),

- Deputy Chairman of the Committee on Metrology and Scientific Equipment, Polish Academy of Sciences (2020-2024)

- Deputy Chairman of the AEEiTK Scientific Council of the MUT (since 2020)

- Member of the Honorary Dignities Chapter, MUT (since 2024)

- Member of the Medal of Merit Chapter, MUT (since 2025)

- Member of the Senate of MUT (2016-2020)

- Member of the Scientific Committee of the Metrology Congress (2016, 2019, 2023)

- Member of the Scientific Committee of the National Conference on Metrology (2021, 2025)

- Member of the Program Committee of the Scientific and Technical Conference on Radiolocation (2022, 2023)

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Research project entitled "*Development of a Mobile Precision Time and Frequency Counter*," 2024-2026, funded by the Ministry of Science and Higher Education under the Polish Metrology II program.
2. Research project entitled "*National Research Infrastructure for the Development of GNSS/ADS-B Systems with Particular Emphasis on Automatic Threat Detection*," 2024-2029, funded under the "European Funds for a Modern Economy (FENG)" program.

3. University Research Grant entitled "*Methods of Precise Time-to-Digital Conversion and Clock Signal Source Stabilization for Time Metrology and Synchronous Wireless Measurement of Biomedical Signals*," 2025.
4. University Research Grant entitled "*Advanced Methods of Measurement and Data Processing in Time Metrology Applications and Medical Equipment*," 2024.
5. University Research Grant entitled "*Adaptive Calibration of Precision Integrated Time Counters*," 2021
6. University Research Grant: "*Precise Calibration of Integrated Time-to-Digital Converters with Subpicosecond Resolution*," 2020
7. Research and Implementation Project: "*Development of a Multifunctional Time and Frequency Counter*," 2019-2020, funded under the WAT-Pendulum agreement.

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Number of publications: 212, including:
- publications from the Master Journal List: 51,
- journal articles: 56,
- monographs and books: 2,
- chapters in monographs and books: 2,
- conference papers: 63, including presented at international conferences: 28,
- patents and utility models: 3 / 4.

Hirsch index: 16 (according to WoS, Scopus)
Web of Science (20/10/2025): no. of publications – 51, no. of citations – 989.
Scopus (20/10/2025): no. of publications – 60, no. of citations – 1077.

1. Szplet, R., et al., "*High-precision 3-channel time interval counter in a low-cost AMD Spartan-7 FPGA*", Metrology and Measurement Systems, 2025
2. Kwiatkowski, P; Sondej, D and Szplet, R., "*Subpicosecond resolution time interval counter with multisampling wave union type B TDCs in 28 nm FPGA device*", Measurement, 2023
3. Achtenberg, K; Szplet, R and Bielecki, Z., "*Advanced, Real-Time Programmable FPGA-Based Digital Filtering Unit for IR Detection Modules*", Electronics, 2024
4. Frankowski, R; Gurski, M and Szplet, R., "*KINTEX ultrascale's multi-segment digital tapped delay lines with controlled characteristics for precise time-to-digital conversio*n", Metrology and Measurement Systems, 2024
5. Kwiatkowski, P; Sondej, D and Szplet, R., "*Bubble-Proof Algorithm for Wave Union TDCs*", Electronics, 2022
6. Szplet, R and Czuba, A., "*Two-Stage Clock-Free Time-to-Digital Converter Based on Vernier and Tapped Delay Lines in FPGA*", Electronics, 2021

7. Sondej, D; Szymanowski, R and Szplet, R., “M*ethods of precise determining the transfer function of picosecond time-to-digital converters*”, Metrology and Measurement Systems, 2021

8. Kwiatkowski, P and Szplet, R., „*Efficient Implementation of Multiple Time Coding Lines-Based TDC in an FPGA Device*”, IEEE Transactions on Instrumentation and Measurement, 2020

9. Kwiatkowski, P; Sondej, D and Szplet, R., “*A brief review of wave union TDCs*”, 7th International Conference on Event-Based Control, Communication and Signal Processing (EBCCSP), 2021

Education activities
(modules, average number of hours of classes, in the last 5 years)

1. Digital Circuits – original course taught in English as part of the Erasmus program.
2. ASIC Design – original course taught in English as part of the Erasmus program.
3. Digital Circuits – Faculty of Electronics, MUT, first-cycle studies.
4. Digital Circuit Technology – Faculty of Electronics, MUT, first-cycle studies.
5. Programmable Circuit Technology – Faculty of Electronics, MUT, first-cycle studies.
6. Programmable Digital Circuits – Faculty of Electronics, MUT, second-cycle studies.
7. Specialized Circuits (original course) – Faculty of Electronics, MUT, second-cycle studies.
8. Analog-to-Digital Converters (original course) – Faculty of Electronics, MUT, second-cycle studies.
9. Design of Application Specific Digital Circuits (original course) – Faculty of Electronics, MUT, second-cycle studies.
10. Programmable and Specialized Integrated Circuits (original course) – SDR, MUT, third-cycle studies.

Average number of classes per year – approx. 300 hours.

Achievements
(awards, distinctions, patents in the last 5 years)

1. Knight's Cross of the Order of Polonia Restituta (President of the Republic of Poland, 2021)
2. Gold Medal for Long Service (President of the Republic of Poland, 2023)
3. Rector's Team Award for scientific achievements, "*Development and testing of a secure communications system operating in tactical activities in Software-Defined Networks*", 2024
4. Rector's Team Award for scientific achievements, "*Development of an innovative system ensuring effective and rapid identification of victims of disasters or terrorist attacks*", 2023

5. Rector's Team Award for organizational achievements, "*Establishment of the Radio Scientific and Didactic Center of the Faculty of Electronics*", 2023

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors: 5

Number of reviews in doctoral dissertations (4) and habilitation proceedings (8), as well as opinions in professorial proceedings (4) in the last 5 years.

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID
prof. dr Janusz Bogusz, 0000-0002-0424-7022
Position, management function
Vice-Rector for Scientific Affairs
Scientific discipline represented (scientific disciplines %)
Civil engineering, geodesy and transport (100%)
Area of scientific interest
physical geodesy, geodynamics, geodetic reference systems and frames, geodetic time series analysis
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
President of Committee 3 'Earth Rotation and Geodynamics' of the International Association of Geodesy (IAG) Expert of the Commission for the Evaluation of Science on the evaluation of scientific achievements and descriptions of the impact of scientific activities on the functioning of the economy and society Member of the Scientific Council of the Institute of Geodesy and Cartography Member of the Scientific Excellence Council Member of the Committee on Geodesy, Polish Academy of Sciences Member of the Advisory Board on Research Infrastructure to the Minister of Science
Research activities *(participation in programs, projects, grants, method of financing, in the last 5 years)*
Principal Investigator in the project of the National Science Centre, OPUS-21 on "Study of the evolution of the stochastic character of the geodetic time series in the context of the future realisation of the Earth reference system", contract no UMO-2021/41/B/ST10/01458. Investigator in the project of the National Science Centre, OPUS-23 on " A novel approach for spatially completing irregular GPS displacement fields to obtain high-resolution Total Water Storage (TWS) changes", contract no. UMO-2022/45/B/ST10/00333. Investigator in the project of the National Science Centre, OPUS-24 on " A new approach for inferring spatially continuous multi-technique vertical land motion (VLM) models for coastal areas and sea level research", contract no. UMO-2022/47/I/ST10/01119.
Publishing activities *(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)*
183, 20 (WoS), 19 (Scopus)

1. Bogusz J., Rebischung P., Klos A. (2025). Impact of alignment strategy to the reference frame on the 3D annual station motions from different GNSS solutions. Journal of Geodesy, doi: 10.1007/s00190-025-02009-6.
2. Lenczuk A., Olivera-Guerra L., Klos A., Bogusz J. (2024). On the ability to study regional hydrometeorological changes using GPS and GRACE measurements. Progress in Earth and Planetary Science, 11:63, doi:10.1186/s40645-024-00665-4.
3. Lenczuk A., Ndehedehe C., Klos A., Bogusz J. (2024). A new Multivariate Drought Severity Index to identify short-term hydrological signals: case study of the Amazon River basin. Remote Sensing of Environment, Vol. 315, 114464, doi:10.1016/j.rse.2024.114464.
4. Kermarrec G., Maddanu F., Klos A., Proietti T., Bogusz J. (2024). Modelling trends and periodic components in geodetic time series: a unified approach. Journal of Geodesy 98, 17 (2024), doi:10.1007/s00190-024-01826-5.
5. Kermarrec G., Klos A., Lenczuk A., Bogusz J. (2023). Long-term temporal-scales of hydrosphere changes observed by GPS over Europe: a comparison with GRACE and ENSO. IEEE Geoscience and Remote Sensing Letters, doi:10.1109/LGRS.2023.3345540.
6. Klos A., Kusche J., Leszczuk G., Gerdener H., Schulze K., Lenczuk A., Bogusz J. (2023). Introducing the idea of classifying sets of permanent GNSS stations as benchmarks for hydrogeodesy. Journal of Geophysical Research: Solid Earth, doi:10.1029/2023JB026988.
7. Lenczuk A., Kłos A., Bogusz J. (2023). Studying spatio-temporal patterns of vertical displacements caused by groundwater mass changes observed with GPS. Remote Sensing of Environment, Vol. 292, 113597, doi:10.1016/j.rse.2023.113597.
8. Klos A., Bogusz J., Pacione R., Humprey V., Dobslaw H. (2023). Investigating temporal and spatial patterns in the stochastic component of ZTD time series over Europe. GPS Solutions (2023) 27:19, doi:10.1007/s10291-022-01351-y.
9. Klos A., Dobslaw H., Dill R., Bogusz J. (2021). Identifying the sensitivity of GPS to non-tidal loadings at various time resolutions: examining vertical displacements from continental Eurasia. GPS Solutions (2021) 25:89, doi:10.1007/s10291-021-01135-w.
10. Ejigu Y.G., Teferle F.N., Klos A., Bogusz J., Hunegnaw A. (2021). Monitoring and prediction of hurricane tracks using GPS tropospheric products. GPS Solutions (2021) 25:76, doi: 10.1007/s10291-021-01104-3.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Spherical astronomy
Reference systems and basics of geodesy
Physical geodesy and geodetic gravimetry
Reference systems in geosciences (SDR)
Global Geodetic Observing System (SDR)
Reference systems in geodesy
Geodynamics
Reference Systems in Geodesy and Navigation
Analysis and modelling of the Earth's gravity field
223 hours

Achievements

(awards, distinctions, patents in the last 5 years)

bronze medal 'Armed Forces at the Service of the Fatherland'

Prof. Lubomir Włodzimierz Baran Award

author of utility model No. W.131420 "Gravimeter stand"

laureate of the medal "For Merits to the Wrocław University of Life Sciences"

title "Distinguished Academic Teacher of the Military University of Technology"

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors: 0.

Reviewer of doctoral dissertations: 2.

Reviewer in habilitation proceedings: 1.

Opinions in professorial proceedings: 0.

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Scientific Business Card

Title/degree Name and Surname, No ORCID
Prof. Anna Borucka, D.Sc., Ph.D., Eng.
Position, management function
Associate professor
Scientific discipline represented (scientific disciplines %)
Civil Engineering, Geodesy and Transport 50% Security Studies 50%
Area of scientific interest
Mathematical modeling of transportation systems and processes. Data analysis in transportation, statistical analysis and statistical inference. Analysis and assessment of the level of readiness of transportation systems. Assessment and formation of the reliability of transportation assets. Optimization of logistics activities of civilian enterprises and military units. Forecasting in logistics systems.
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
1. Member of the Artificial Intelligence and Cyber Security in Transportation Section of the Polish Academy of Sciences - since 2025. 2. Member of the Polish Society of Technical Diagnostics (PTDT) since 2024. 3. Member of the Scientific Council of LOGI - Scientific Journal on Transport and Logistics - since 2024. 4. Member of the Scientific Council of the Journal of Vasyl Stefanyk Precarpathian National University published in Ukraine - since 2024. 5. Member of the Scientific Council of the Journal of Internal Security published by the Police Academy in Szczytno - since 2024. 6. Editor-in-Chief of the quarterly Maintenance and Reliability - Maintenance and Reliability, since 2022. 7. Member of the Scientific Council of Scientific Bulletin of Kyiv Institute of the National Guard of Ukraine, since 2023. 8. Subject Editor in the area of: logistics in emergency situations in the Scientific Journals of the Institute of Logistics of the WAT in the Scientific Journals of the Institute of Logistics of the WAT Army Logistics Systems, since 2023. 9. Member of the Scientific Council of the Scientific Bulletin of Chelm - Section of Pedagogy, since 2022. 10. Member of the Polish Scientific Society of Combustion Engines, since 2023.

11. Expert in the national consulting team under the agreement between the Minister of Finance and the Minister of Defense for expert opinions on unmanned aerial vehicles seized by the National Tax Administration, since 2023.

12. Expert of the Polish Maintenance Society, from 2022.

13. Member of the Board of Directors (Treasurer) of the Polish Scientific and Technical Society of Exploitation, by election, since 2019.

14. Member of the Polish Maintenance Society, since 2018.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Scientific project No. SMN/18/1573/2022 within the framework of the program entitled Scholarship for an outstanding young scientist, assigned by the Ministry of Education and Science, Manager 09.2023- 08.2026.
2. International project funded by the International Visegrad Fund entitled: “Innovative education according to the needs of Industry 4.0 principles in V4 countries” No. 22320035 contractor, 1.10.2023 - 30.04.2025
3. Project within the framework of the Central European Exchange Programme for University Studies (CEEPUS) program entitled Educational Systems in Central Europe (HR-1005-00-2425), contractor, 26.03.2024-30.09.2025.
4. Project under the Excellent Science II program - Support for scientific conferences entitled Challenges of the scientific community in the face of the conflict in Ukraine, manager, 2023-2024. KONF/SP/0100/2023/01
5. University Research Grant No. 757/2024 entitled Improving selected logistics processes using innovative technologies and methods based on artificial intelligence, contractor, 2024.
6. University Research Grant No. 759/2024 entitled Logistics security system of ground troops in tactical operations, contractor, 2024.
7. University Research Grant No. 846/2023 entitled Application of heuristic optimization algorithms in improving the safety of transportation processes, manager, 2023.
8. International project entitled Digital Twin Based Fault Prediction and Maintenance Method for Intelligent Instruments (Grant No. G2021177009L) carried out in collaboration with Beihang University, Institute of Reliability Engineering, People's Republic of China, contractor, 2021 -2022.
9. Participation in Erasmus+ program, Institute of Technology and Business in České Budějovice, 20-25.10.2024, Czech Republic.
10. Participation in the Erasmus+ program, Aviation Institute, Riga Technical University. 26.02. - 01.03.2024, Latvia.

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

200 publications

Web of Science - Hirsch index 15

Scopus - Hirsch index 17
Google scholar - Hirsch index 28
Selected publications:

1. Borucka A. Analysis and modeling of transportation processes, Publishing House of the Military University of Technology, Warsaw, 2025, ISBN 978-83-7938-435-8.
2. Kozlowski, E., Borucka, A., Oleszczuk, P., Leszczynski, N. (2024). Evaluation of readiness of the technical system using the semi-Markov model with selected sojourn time distributions. Eksploatacja i Relawodność - Maintenance and Reliability. https://doi.org/10.17531/ein/191545
3. Borucka, A., Kozlowski, E. Selected polynomial identification techniques to evaluate maritime transport trends around Covid-19. Scientific Journal of Silesian University of Technology. Series Transport. 2023, 120, 51-68. ISSN: 0209-3324. DOI: https://doi.org/10.20858/sjsutst.2023.120.4 4
4. Borucka, A.; Sobczuk, S. Analysis of the Relationship Between Energy Consumption in Transport, Carbon Dioxide Emissions and State Revenues: The Case of Poland. Energies 2025, 18, 2291. https://doi.org/10.3390/en18092291
5. Borucka A., Wiśniowski P., Mazurkiewicz D., Świderski A. Laboratory measurements of vehicle exhaust emissions in conditions reproducing real traffic, Measurement, 174, 2021, 108998, https://doi.org/10.1016/j.measurement.2021.108998

Education activities
(modules, average number of hours of classes, in the last 5 years)

Statistical Methods in Social Research (SD)
Forecasting and Simulation in Security (SD)
Production Logistics (First Degree)
Pensum - 170 hours

Achievements
(awards, distinctions, patents in the last 5 years)

1. Scholarship of the Minister of Education and Science for outstanding young scientists, 2023.
2. Scholarship of the Rector-Commander of WAT for publication activities, 2019.
3. Applications for 14 patents have been filed
4. Bronze medal for long-standing military service -2023.
5. The Medal of the National Education Commission -2022.
6. Honorary title of Meritorious Soldier of the Republic of Poland 2022.
7. Silver medal for Meritorious Service to National Defense - 2021.
8. Silver medal Armed Forces in the Service of the Fatherland, 2021.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Promoted Doctorates - 3 (one as assistant promoter)
In Doctoral School - 7 Doctoral Students (promoter) 1 Doctoral Student (assistant promoter)
Reviews in doctoral proceedings - 4
Reviews in postdoctoral proceedings - 2

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Professor Adam Stolarski, Ph.D., D.Sc., ORCID: 0000-0002-4754-3067

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Civil engineering, geodesy and transport

Area of scientific interest

1. Numerical modelling of the static and dynamic behaviour of structural materials (steel model, concrete model, reinforced concrete model as a homogeneous substitute material).
2. Numerical simulation of non-linear processes of static and dynamic deformation of material compositions (reinforced concrete elements, concrete prestressed elements) and of structural compositions (steel ribbed elements).
3. Experimental and numerical studies of reinforced concrete elements with original spatial reinforcement systems.
4. Experimental tests of concrete.
5. Research on energy consumption of buildings.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

1. Committee for the mid-term evaluation of doctoral students at the Doctoral School of the Military University of Technology – chairman of the committee in the scientific discipline of civil engineering, geodesy and transport in 2024, 2025.
2. Recruitment Committee of the Military University of Technology Doctoral School – chairman of the committee in the scientific discipline of civil engineering and transport / civil engineering, geodesy and transport 2019, committee member since 2020.
3. Member of the Committee for the mid-term evaluation of doctoral students of the Białystok University of Technology in the scientific discipline of civil engineering, geodesy and transport in 2023, 2024.
4. Member of the Scientific Council of the Building Research Institute in Warsaw, appointed by the Minister of Infrastructure and Construction, since 2018.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. UGB WAT Research Grant No. 814/2023. Testing of ribbed steel plates using explosives - WAT team leader.
2. UGB WAT Research Grant No. 704/2024. Testing of ribbed steel plates using explosives - WAT team leader.

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

total number of publications:
Monographs - 3, Chapters in monographs - 12, Designer's Guide - 1, Script - 1
Articles - 94,
Papers at International Conferences - 14, Papers at International Conferences in Poland - 15, Papers at National Conferences – 43

Hirsch Index: Web of Science h=5, Scopus h=6, Google Scholar h=10

the most important publications in the last 5 years:

1. S. Onopiuk, A. Stolarski, R. Rekucki. Numerical prognosis of the dynamic response of the steel rectangular slab under the explosive load. Archives of Civil Engineering, Vol. LXXI, ISSUE 2, 2025, 473 –489, DOI: 10.24425/ace.2025.154132.
2. A. Szcześniak, A. Stolarski. Experimental verification of innovative spatial reinforcement of ultra-high performance concrete with mesh tubes. Cement and Concrete Composites, Vol. 150, July 2024, 105561, https://doi.org/10.1016/j.cemconcomp.2024.105561.
3. 3. J. Siwiński; A. Szcześniak; K. Kubiak; A. Stolarski. Experimental Calibration of a Homogeneous Substitute Material Model for Reinforced High-Performance Concrete Modeling. Materials 2023, 16, 5056. https://doi.org/10.3390/ma16145056.
4. 4. A. Jancy, A. Stolarski, J. Zychowicz. Experimental and Numerical Research of Post-Tensioned Concrete Beams. Materials 2023, 16, 4141. https://doi.org/10.3390/ma16114141.
5. A. Stachera, A. Stolarski, M. Owczarek, M. Telejko. A Method of Multi-Criteria Assessment of the Building Energy Consumption. Energies 2023, 16(1), 183. https://doi.org/10.3390/en16010183.
6. J. Siwiński, A. Szcześniak, B. Nasiłowska, Z. Mierczyk, A. Stolarski. Effect of the mix composition with superplasticizer admixture on mechanical properties of high – strength concrete based on reactive powders. Archives of Civil Engineering, Vol. LXVIII, Issue 4, 2022, 77-95. DOI: 10.24425/ace.2022.143027.
7. J. Siwiński, A. Szcześniak, G. Rutkowska, K. Kubiak, A. Stolarski. Integrated effects of concrete samples size and fibers amount on compressive strength of high- and ultra-high strength concretes based on reactive powders. Structural Concrete, 2022, International Federation for Structural Concrete, https://doi.org/10.1002/suco.202200417.
8. P. Smarzewski, A. Stolarski. Properties and Performance of Concrete Materials and Structures. Crystals 2022, 12, 1193, 1-5, https://doi.org/10.3390/cryst12091193.
9. A. Szcześniak, J. Siwiński, A. Stolarski. Effect of Aggregate Type on Properties of UltraHigh-Strength Concrete. Materials 2022, 15, 5072, https://doi.org/10.3390/ ma15145072.
10. A. Stolarski, J. Zychowicz. Experimental Investigations of Reinforced Concrete Beams with Innovative Truss-Shaped Reinforcement System. Materials 2021, 14(7), 1652; https://doi.org/10.3390/ma14071652.
11. J. Siwiński, A. Szcześniak, A. Stolarski. Modified Formula for Designing Ultra-High-Performance Concrete with Experimental Verification. Materials. Materials, 2020, 13, 4518, doi:10.3390/ma13204518.
12. A. Szcześniak, J. Zychowicz, A. Stolarski. Influence of Fly Ash Additive on the Properties of Concrete with Slag Cement. Materials, 2020, 13(15), 3265, doi:10.3390/ma13153265.
13. W. Cichorski, A. Stolarski. Prognosis of dynamic behavior of reinforced concrete deep beams of very high strength materials. Archives of Civil Engineering, Vol. LXVI, Issue 1/2020, 247-279, DOI: 10.24425/ace.2020.131787.

Education activities
(modules, average number of hours of classes, in the last 5 years)

modules:
Concrete structures, Complex concrete bridge structures, Building and engineering structures, Theory of structures, Theory of elasticity and plasticity, Dynamics of structures
including in SDR:
Geometric and physical nonlinearities in structural mechanics
Modelling the behaviour of reinforced concrete elements and structures
total number of hours of classes: 13860
average number of hours of classes in the last 5 years: 259
supervisor of diploma theses: master's theses – 123, engineering theses – 31

Achievements
(awards, distinctions, patents in the last 5 years)

Patents:

1. Flat grids system with the lattice arrangement of bars for concrete reinforcement.
   Patent description PL 226083 B1, 05.12.2016.
   Number of patent declaration 398305, 05.03.2012.
   Patent holder Military University of Technology, Warsaw, Poland.
   Authors: Adam Stolarski, Jacek Zychowicz
2. Spatial Reinforcement of Concrete.
   Patent Description PL 239695 B1, 16.11.2021.
   Number of Patent Declaration P.425667, 22.05.2018.
   Patent holder Military University of Technology, Warsaw, Poland.
   Authors: Anna Szcześniak, Adam Stolarski

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

1. Number of promoted doctors: total – 8, in the last 5 years – 2 and 1 planned doctoral dissertation defense on November 6, 2025.
2. Number of reviews:
   doctoral dissertation: total – 7, in the last 5 years – 2
   in habilitation proceedings: total – 4, in the last 5 years – 3
   in professorial proceedings: total – 7, in the last 5 years – 4

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID
Colonel Michał Kędzierski, PhD, Eng., ORCID ID: 0000-0002-0684-3717
Position, management function
Professor, Dean of the Faculty of Civil Engineering and Geodesy, Military University of Technology
Scientific discipline represented (scientific disciplines %)
Civil engineering, geodesy and transport (100%)
Area of scientific interest
digital image processing satellite photogrammetry
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
• Dean of Faculty of Civil Engineering and Geodesy (FCEG)(September 2019 – present) • Chairman of the Scientific Council for Civil engineering, geodesy and transport (September 2019 – present) • Director of the FCEG Institute of Geodesy (September 2012 – September 2019)
Research activities *(participation in programs, projects, grants, method of financing, in the last 5 years)*
• Project manager of the classified project RÓJ, commissioned by the Ministry of National Defense, 2021-2024 • Project manager of the Intelligent, integrated system for locating, preliminary assessment, and medical assistance to casualties on the battlefield using geoinformation and biomedical sensors, code name MILGEOMED, DOB-SZAFIR/09/A/010/01/2021 • Contractor for the PIAST (Polish ImAging SaTellites) nanosatellite constellation for optoelectronic image reconnaissance, DOB-SZAFIR/10/A/022/01/2021 • Contractor: Automatic detection and identification of military equipment (SpW) on satellite images, Ministry of National Defense 423/2022/DA/GB2 • Project manager Radiometric correction of images obtained from low altitude, Ministry of National Defense, GB/1/2018/205/2018/DA
Publishing activities *(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)*
1. Lewinska M, **Kedzierski M.** The Analysis of the Possibility to Conduct Orbital Manoeuvres of Nanosatellites in the Context of the Maximisation of a Specific Operational Task. *Applied Sciences*. 2025; 15(10):5360. https://doi.org/10.3390/app15105360 2. K. Karwowska, D. Wierzbicki and **M. Kedzierski**, "Image Inpainting and Digital Camouflage: Methods, Applications, and Perspectives for Remote Sensing," in

IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 18, pp. 8215-8247, 2025, doi: 10.1109/JSTARS.2025.3547917

3. Glinka Sz., Bajer J., Wierzbicki D., Karwowska K., **Kędzierski M.**, The Use of Deep Learning Methods for Object Height Estimation in High Resolution Satellite Images, Sensors, 2023, vol. 23, nr 19, s.1-21, Numer artykułu: 8162. doi:10.3390/s23198162
4. Jenerowicz A., Wierzbicki D., **Kędzierski M.**, Radiometric Correction with Topography Influence of Multispectral Imagery Obtained from Unmanned Aerial Vehicles, Remote Sensing, 2023, vol. 15, nr 8, s.1-25, Numer artykułu: 2059. doi:10.3390/rs15082059
5. Kwapień K., Lasota P., **Kędzierski M.**, Walczykowski P., Design and Performance Analysis of a Constellation of Nanosatellites to Monitor Water Quality in the Southern Catchment of the Baltic Sea, Sensors, 2023, vol. 13, nr 23, Numer artykułu: 6192. doi:10.3390/s23136192
6. Ślesiński J., Wierzbicki D., **Kędzierski M.**, Application of Multitemporal Change Detection in Radar Satellite Imagery Using REACTIV-Based Method for Geospatial Intelligence, Sensors, 2023, vol. 23, nr 10, s.1-26, Numer artykułu: 4922. doi:10.3390/s23104922
7. Fryśkowska A., Delis P., **Kędzierski M.**, Matusiak D., The Conception of Test Fields for Fast Geometric Calibration of the FLIR VUE PRO Thermal Camera for Low-Cost UAV Applications, Sensors, 2022, vol. 22, nr 7, s.1-24, Numer artykułu: 2468. DOI:10.3390/s22072468
8. Wojtkowska M., **Kędzierski M.**, Deliś P. Validation of terrestrial laser scanning and artificial intelligence for measuring deformations of cultural heritage structures. Measurement, Volume 167, 1 January 2021, 108291, doi:10.1016/j.measurement.2020.108291
9. Lalak M., Wierzbicki D., **Kędzierski M.**, Methodology of Processing Single-Strip Blocks of Imagery with Reduction and Optimization Number of Ground Control Points in UAV Photogrammetry, Remote Sensing, 2020, vol. 12, nr 20, s.1-35, Numer artykułu: 3337. doi:10.3390/rs12203336
10. Reda K., **Kędzierski M.** Detection, Classification and Boundary Regularization of Buildings in Satellite Imagery Using Faster Edge Region Convolutional Neural Networks. Remote Sensing 2020, 12(14), 2240, doi:10.3390/rs12142240
11. Sekrecka A., Wierzbicki D., **Kędzierski M.** Influence of the Sun Position and Platform Orientation on the Quality of Imagery Obtained from Unmanned Aerial Vehicles. Remote Sensing, 12(6), 1040; doi:10.3390/rs12061040
12. Wierzbicki, D.; **Kedzierski, M**.; Sekrecka, A. A Method for Dehazing Images Obtained from Low Altitudes during High-Pressure Fronts. Remote Sens. 2020, 12, 25. DOI: 10.3390/rs12010025

Index Hirscha: Web of Science – 14

Scopus - 15

Education activities
(modules, average number of hours of classes, in the last 5 years)

Photogrammetry
basics of photogrammetry and remote sensing

satellite photogrammetry
seminar
Average number of lecture hours - 200 hours

Achievements
(awards, distinctions, patents in the last 5 years)

Gold Medal for *Merit to National Defense*

Gold Medal for *Armed Forces in the Service of the Fatherland*

Military Cross of Merit

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors: 2

Reviewer of doctoral dissertations: 3

Reviewer in habilitation proceedings: 4

Opinions in professorial proceedings: 1

Contact

Place of work: building no./room no.: 59/106

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Scientific Business Card

Title/degree Name and Surname, No ORCID
dr hab. inż. Anna Kłos, ORCID: 0000-0001-6742-8077
Position, management function
university professor in the research and teaching staff group
Scientific discipline represented (scientific disciplines %)
civil engineering, geodesy and transportation (100%)
Area of scientific interest
satellite geodesy
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
2019-present: visiting researcher at the University of Bonn, Germany, as a Mercator Fellow, as part of the grant: “New Refined Observations of Climate Change from Spaceborne Gravity Missions (NEROGRAV)” awarded by the German Research Foundation DFG (German: Deutsche Forschungsgemeinschaft). 2019-present: Member of the steering panel of the Inter-Commission Committee on “Geodesy for Climate Research” of the International Association of Geodesy 2019-present: Deputy Editor-in-Chief of the “Journal of Geodesy”, published by Springer 2019-present: Member of the Program Council of the journal “GPS Solutions”, published by Springer 2019-present: Member of the science panel of the Global Geodetic Observing System GGOS project of the International Association of Geodesy 2019-present: Member of 5 international research groups operating under the auspices of the International Association of Geodesy (IAG) 2020-2028: Member of the Presidium of the Committee on Geodesy of the Polish Academy of Sciences 2020-present: Editor-in-chief of the journal “Advances in Geodesy and Geoinformation” published by the Polish Academy of Sciences (formerly “Geodesy and Cartography”) 2020-2022: Coordinator of the competition for the best presentations by young scientists at the AGU conference in the Geodesy Section (Geodesy Section Outstanding Student Poster Awards) 2020-2022: Member of the steering panel of the Geodesy Section of the American Geophysical Union (AGU) 2021-2025: Science officer on the steering committee of the Geodesy Division of the European Geosciences Union (EGU) 2022-2023: Vice-President of the Polish Young Academy of the Polish Academy of Sciences

2022-2026: Member of the Polish Young Academy of the Polish Academy of Sciences

2023-present: Member of the group of young scientists appointed as an advisory body to the executive committee of the International Association of Geodesy (IAG), representative of IAG Commission 1

2024-2025: Member of the Falkenberg Award Committee of the American Geophysical Union (AGU)

2025: Member of the Team for Women in Higher Education and Science at the Ministry of Science

2025-present: President-Elect of the Geodesy Division of the European Geosciences Union (EGU)

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

06.2018-06.2022: main contractor in the Ministry of National Defense project on “The use of modern satellite techniques to assess environmental changes in the context of studying European subsidy areas,” Research Grant project.

04.2019-present: contractor as a Mercator Fellow in a project awarded by the German Research Foundation (DFG) on “New Refined Observations of Climate Change from Spaceborne Gravity Missions (NEROGRAV)”.

12.2021-present: contractor in a project of the National Science Centre (NCN) on “Study on evolution of noise in the context of future terrestrial reference frame realizations”, agreement no. UMO-2021/41/B/ST10/01458.

01.2023-present: PI for the National Science Centre (NCN) project on “A novel approach for spatially completing irregular GPS displacement fields to obtain high-resolution Total Water Storage (TWS) changes”, agreement no. UMO-2022/45/B/ST10/00333, OPUS, project carried out in international cooperation with JPL NASA, USA.

12.2023-present: PI of the National Science Centre (NCN) project on “A new approach for inferring spatially continuous multi-technique vertical land motion (VLM) models for coastal areas and sea level research”, agreement no. UMO-2022/47/I/ST10/01119, OPUS-LAP, implemented with the University of Bonn, Germany.

09.2025-present: contractor and secondary proposer in a project funded by the European Union under the COST action on "Climate Reference Instruments and Measurements (Upper-air, Column and Near Surface) (CRIM), COST action no. CA24155.

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Number of publications: 67

Hirsch index according to Web of Science: 19, number of citations: 1176

Hirsch index according to Scopus: 19, number of citations: 1189

Most important publications:

1. Van Malderen R., Pottiaux E., Klos A., Domonkos P., Elias M., Ning T., Bock O., Guijarro J., Alshawaf F., Hoseini M., Quarello A., Lebarier E., Chimani B., Tornatore V., Zengin Kazanci S., Bogusz J. (2020): Homogenizing GPS integrated water vapor time series: benchmarking break detection methods on synthetic datasets. Earth and Space Science, 7(5), DOI: 10.1029/2020EA001121.
2. Ejigu Y.G., Teferle F.N., Klos A., Bogusz J., Hunegnaw A. (2021): Monitoring and prediction of hurricane tracks using GPS tropospheric products. GPS Solutions, 25(2), DOI: 10.1007/s10291-021-01104-3.
3. Klos A., Dobslaw H., Dill R., Bogusz J. (2021): Identifying the sensitivity of GPS to non-tidal loadings at various time resolutions: examining vertical displacements from continental Eurasia. GPS Solutions, 25, 89, DOI: 10.1007/s10291-021-01135-w.
4. Klos A., Karegar M.A., Kusche J., Springer A. (2021): Quantifying noise in Daily GPS Height Time Series: Harmonic Function Versus GRACE-assimilating modeling approaches. IEEE Geoscience and Remote Sensing Letters, 18(4), 627-631. DOI: 10.1109/LGRS.2020.2983045.
5. Richter H.M.P., Luck C., Klos A., Sideris M.G., Rangelova E., Kusche J. (2021): Reconstructing GRACE-type time-variable gravity from the Swarm satellites. Scientific Reports, 11, 1117. DOI: 10.1038/s41598-020-80752-w.
6. Yuan P., Hunegnaw A., Alshawaf F., Awange J., Klos A., Teferle F.N., Kutterer H. (2021): Feasibility of ERA5 integrated water vapor trends for climate change analysis in continental Europe: An evaluation with GPS (1994–2019) by considering statistical significance. Remote Sensing of Environment, 260, 112416, DOI: 10.1016/j.rse.2021.112416.
7. Gerdener H., Kusche J., Schulze K., Döll P., Klos A. (2023): The global land water storage data set release 2 (GLWS2.0) derived via assimilating GRACE and GRACE-FO data into a global hydrological model. Journal of Geodesy, 97, 73, DOI: 10.1007/s00190-023-01763-9.
8. Klos A., Bogusz J., Pacione R., Humphrey V., Dobslaw H. (2023): Investigating temporal and spatial patterns in the stochastic component of ZTD time series over Europe. GPS Solutions, 27(1), DOI: 10.1007/s10291-022-01351-y.
9. Klos A., Kusche J., Leszczuk G., Gerdener H., Schulze K., Lenczuk A., Bogusz J. (2023): Introducing the Idea of Classifying Sets of Permanent GNSS Stations as Benchmarks for Hydrogeodesy. Journal of Geophysical Research: Solid Earth 128, e2023JB026988, DOI: 10.1029/2023JB026988.
10. Lenczuk A., Klos A., Bogusz J. (2023): Studying spatio-temporal patterns of vertical displacements caused by groundwater mass changes observed with GPS. Remote Sensing of Environment, 292, 113597, DOI: 10.1016/j.rse.2023.113597.
11. Kermarrec G., Klos A., Lenczuk A., Bogusz J. (2023): Long-Term Temporal Scales of Hydrosphere Changes Observed by GPS Over Europe: A Comparison With GRACE and ENSO. IEEE Geoscience and Remote Sensing Letters, 21, 1500605, 1-5, DOI: 10.1109/LGRS.2023.3345540.

12. Kermarrec G., Maddanu F., Klos A., Proietti T., Bogusz J. (2024): Modeling trends and periodic components in geodetic time series: a unified approach. Journal of Geodesy, 98(17), DOI: 10.1007/s00190-024-01826-5.
13. Lenczuk A., Ndehedehe C., Klos A., Bogusz J. (2024): A new Multivariate Drought Severity Index to identify short-term hydrological signals: case study of the Amazon River basin. Remote Sensing of Environment, 315, 114464, DOI: 10.1016/j.rse.2024.114464.
14. Lenczuk A., Olivera-Guerra L., Klos A., Bogusz J. (2025): On the ability to study regional hydrometeorological changes using GPS and GRACE measurements. Progress in Earth and Planetary Science, 11, 63, DOI: 10.1186/s40645-024-00665-4.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Courses taught: Basic Geodesy, Reference Frames in Geodesy, Geodynamics, Diploma Seminars, Geodetic Time Series Analysis, Reference Frames in Geodesy

Average number of hours: 200

Achievements
(awards, distinctions, patents in the last 5 years)

1. Scholarship from the Minister of Science and Higher Education for outstanding young scientists. Awarded for a period of 36 months – 2020-2023.

2. European Geosciences Union (EGU) Award for outstanding young scientists, Geodesy Division, 2021.

3. Scientific Award of the Faculty IV of Technical Sciences of the Polish Academy of Sciences for a series of 19 scientific articles on mathematical modelling of geodetic time series, 2020.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors: 1

Number of reviews of doctoral students: 3 (Wrocław University of Environmental and Life Sciences, 2020, Warsaw University of Technology, 2024 and University of Luxembourg, 2024)

Number of reviews in habilitation proceedings: 1 (University of Warmia and Mazury, 2020)

Reviewer of the scientific achievements of candidates for the position of professor: 1 (Technical University of Munich, 2025)

Member of the Mid-Term Evaluation Committee for Doctoral School Participants at the Doctoral School of Wrocław University of Environmental and Life Sciences, 2022-2025

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID
Dr hab. inż. Ryszard Chmielewski, 0000-0001-5662-9180
Position, management function
University professor
Scientific discipline represented (scientific disciplines %)
Civil Engineering, Geodesy and Transport
Area of scientific interest
Construction, building diagnostics, folding structures
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
Team of military experts within the National security plan ‘Eastern Shield’
Research activities *(participation in programs, projects, grants, method of financing, in the last 5 years)*
A task necessary for defence purposes, consisting in analysing the application of the UBM system and innovative solutions developed at the Military University of Technology for this system, for the construction of defence infrastructure facilities to ensure the safety of own troops and the protection of the civilian population, together with the development of a catalogue of construction solutions, a specific subsidy from the Ministry of National Defence, task manager. Analysis of the condition of engineering structures depending on structural and material solutions, University Research Grant 787, 2023, project manager Determination of the actual stiffness of double-bent sheets, MIC 240 profile, to present design guidelines for the construction of lightweight structures using the UBM system in Poland, University Research Grant, 2025, project manager.
Publishing activities *(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)*
Kamil Sobczyk, Leopold Kruszka, Michał Grążka, Ryszard Chmielewski, Ryszard Rekucki, Preparation of the non-cohesive soil sample and calibration of the pneumatical launcher in the dynamic soil test SHPB, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, 1 (2022) s. 16-27, A, N5, 70 pkt. Leszek Opyrchał, Ryszard Chmielewski, Aleksandra Bąk, New method for comparing of particle-size distribution curves, Archives of Civil Engineering, Vol. LXVIII, ISSUE 1 (2022), s. 63-72, A, N3, 100 pkt. Alicja Ostrowska, Ryszard Chmielewski, Proposal for new technologies of DMS-65 folding bridge construction, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, 2 (2022) s. 23-31, A, N2, 70 pkt. Kamil Sobczyk, Leopold Kruszka, Ryszard Chmielewski, Ryszard Rekucki, Strength characterization of soils’ properties at high strain rates using the hopkinson technique-a review of experimental testing, Materials, Volume 15, Issue 1 (2022), Article number 274, A, N4, 140 pkt. Ryszard Chmielewski, Mariusz Wesołowski, Damian Waliszewski, Review of subgrade bearing capacity tests for airfield pavements, Roads and Bridges - Drogi i Mosty, 21 (2022), s. 117-131, A, N2, 70 pkt.

Ryszard Chmielewski, Jacek Sankowski, Kamil Sobczyk, Wpływ niewłaściwego rozpoznania podłoża gruntowego na realizację inwestycji na terenie zamkniętym, Materiały Budowlane, 2 (2023), s.39-43, A, N2, 140 pkt.
Alicja Ostrowska, Ryszard Chmielewski, Overview of the organisation and technology of portable panel Bridges, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, 1 (2023), s. 46-52, A, N2, 100 pkt.
9. Kamil Sobczyk, Ryszard Chmielewski, Leopold Kruszka, Ryszard Rekucki, Analysis of the Influence of Silty Sands Moisture Content and Impact Velocity in SHPB Testing on Their Compactability and Change in Granulometric Composition, Applied Sciences, Volume 13, Issue 8 (2023), A, N4, 100 pkt.
Ryszard Chmielewski, Jacek Sankowski, Marcin Lisowski, Paweł Muzolf, Diagnostyka uszkodzonych ścian budynków z zastosowaniem monitoringu geodezyjnego, Materiały Budowlane, 7 (2023) s. 18-23, A, N3, 100 pkt.
Ryszard Chmielewski, Aleksandra Bąk, Paweł Muzolf, Kamil Sobczyk, Influence of Calculation Parameters on the Slope Stability of the Historical Rasos Cemetery in Vilnius (Lithuania), Sustainability 16 (7) (2024), A, N4, 100 pkt.
Ryszard Chmielewski, Jacek Sankowski, Analysis of the possibilities of revitalization of historic buildings in the former complex of the spinning mill complex in Lodz, Materiały Budowlane, 8 (2024) s. 18-23, A, N1, 100 pkt.
Ryszard Chmielewski, Andrzej Wolniewicz, Alicja Ostrowska, Erik Mikulski, Dawid Pęksa, Wojciech Huta, Odbudowa infrastruktury transportowej Słowenii z udziałem państw NATO, Przegląd Budowlany 95 (6) (2024), s. 19-23, A, N4, 70 pkt.
Oksana Mariak, Szymon Mitkow, Ryszard Chmielewski, Analysis of rapid reconstruction airport pavements, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych 3 (2024), s. 36-46, A, N3, 70 pkt.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Soil mechanics, Foundations, Bridge engineering, Geotechnics in construction, Special foundations

Achievements
(awards, distinctions, patents in the last 5 years)

May 2024, Krakow, gold medal at the E-NNOVATE trade fair in the Transport and Logistics category, The MSC 23-150 ‘Cis’ bridge, Col. Ryszard Chmielewski, PhD, Eng., Mieczysław Piechota, PhD, Eng., and Andrzej Wolniewicz, PhD, Eng., 1/3

May 2024, Krakow, first place for the best national innovation at the E-NNOVATE fair, The MSC 23-150 ‘Cis’ bridge, Colonel Ryszard Chmielewski, PhD, Eng., Mieczysław Piechota, PhD, Eng., and Andrzej Wolniewicz, PhD, Eng., 1/3

May 2024, Krakow, gold medal at the E-NNOVATE trade fair, device for measuring groundwater pressure under building foundations, Col. Ryszard Chmielewski, PhD, Eng., Tadeusz Łuczak and Capt. Kamil Sobczyk, PhD, Eng., 1/3

May 2024, Krakow, special award ‘Lucian Blaga’ University of Sibiu (delegation from Romania) in recognition of the scientific value and originality of the solution, a device for measuring groundwater pressure under building foundations, Col. Ryszard Chmielewski, PhD, Eng., Tadeusz Łuczak and Capt. Dr. Eng. Kamil Sobczyk, 1/3

W.131808, 4 December 2024, team: Chmielewski R., Baryłka A., Kruszka L., Sobczyk. Ostrowska A., Mikulski E., Steel coating structure panel, Military University of Technology, 1/6

P.438762, 7 August 2025, team: Chmielewski R., Piechota M., Wolniewicz A., Structural element of a road bridge folding girder, Military University of Technology, 1/3

P.445717, 20 March 2025, team: Chmielewski R., Łuczak T., Sobczyk K., Device for measuring piezometric pressure and method for performing such a measurement, Military University of Technology, 1/3

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Promoted doctors: 3

Doctoral thesis reviews: 1

Contact

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Wizytówka naukowa pracownika WAT

Tytuł/stopień naukowy Imię i Nazwisko, Nr ORCID

dr hab. inż. Jan Kelner, prof. WAT, MBA, 0000-0002-3902-0784

Stanowisko, funkcja kierownicza

profesor uczelni b-d, dziekan Wydziału Elektroniki WAT

Reprezentowana dyscyplina naukowa (dyscypliny naukowe %)

Informatyka Techniczna i Telekomunikacja (100%)

Obszar zainteresowań naukowych

Łączność bezprzewodowa, walka radioelektroniczna, propagacja fal radiowych, pomiary i modelowanie kanałów radiowych, efekt Dopplera, radiolokalizacja, radionawigacja, aplikacje dronowe, systemy antydronowe, militarne zastosowanie technologii 5G, ocena jakości usług (QoS) w sieciach mobilnych

Działalność organizacyjna
(udział w pracach różnych gremiów, pełnione funkcje, w ostatnich 5 latach)

- Od 2024 r. dziekan Wydziału Elektroniki WAT
- 2021–2024 dyrektor Instytutu Systemów Łączności Wydziału Elektroniki WAT
- Od 2024 r. członek (senator) Senatu WAT
- Od 2021 r. członek Rady Dyscypliny Naukowej Informatyka Techniczna i Telekomunikacja w WAT
- Od 2024 r. członek Rady Naukowo-Technicznej przy Ośrodku Badawczo – Rozwojowym Centrum Techniki Morskiej S.A. (OBR–CTM S.A.)
- Od 2024 r. członek *EurAAP Delegates Assembly* odpowiedzialny za Delegate Group 9: Estonia, Latvia, Lithuania, Poland w ramach *European Association on Antennas and Propagation* (EurAAP)
- 2024–2025 członek Zarządu *Polish Joint Chapter IEEE AP/AES/MTT* – Zastępca Przewodniczącego ds. AES-S (*IEEE Aerospace and Electronic Systems Society*)
- 2017–2024 główny członek głosujący w Panelu Technologii Systemów Informacyjnych (*Information Systems Technology Panel*) w ramach Organizacja NATO ds. Nauki i Technologii (*NATO Science and Technology Organization* (NATO STO))
- Od 2019 r. ekspert pozarządowy (*CapTech non-Govermental Expert (CnGE)*) w panelu *EDA CapTech (Capability Technology Areas) Communication Information Systems and Networks* w Europejskiej Agencji Obrony (EDA)
- 2020–2024 członek grupy roboczej *IST-187-RTG on 5G technologies application to NATO operations* działającej w ramach NATO STO
- 2023–2026 członek grupy roboczej *IST-SET-204-RTG on RF based detection and classification of UAS* działającej w ramach NATO STO
- Od 2024 r. członek grupy *Autonomous Systems Community of Interests (ASCI)* działającej w ramach EDA
- 2021–2024 członek Zespołu Doradców Społecznych Ministra Obrony Narodowej do spraw Cyberbezpieczeństwa powołany przez Ministra Obrony Narodowej

- Od 2021 r. członek Zespołu ds. opracowania koncepcji wykorzystania technologii 5G w Siłach Zbrojnych RP powołanego Rozkazem Szefa Sztabu Generalnego WP
- 2022–2025 ekspert w Urzędzie Komunikacji Elektronicznej
- Od 2023 r. członek *IEEE P2982 Working Group (WG) on Millimeter-Wave Channel Sounder Verification* w ramach *IEEE Standards Association (SA)*
- Członek stowarzyszeń naukowych: *Institute of Electrical and Electronics Engineers (IEEE)*, *European Association on Antennas and Propagation (EurAAP)*, Polskie Forum Nawigacyjne (PFN), Polskie Towarzystwo Akustyczne (PTA), Stowarzyszenie Elektryków Polskich (SEP)
- 2023–2024 Przewodniczący Komitetu Programowego XIII Konferencji Naukowo-Technicznej Systemy Rozpoznania i Walki Radioelektronicznej (KNTWRE)

Działalność badawcza
(udział w programach, projektach, grantach, sposób finansowania, w ostatnich 5 latach)

- **2022–2025 Europejska Agencja Obrony (EDA)**, EDA Cat. B. Project, Contract No. B.PRJ.RT.832 (PUM/09-027/2022/WAT), **"Łączność dalekiego zasięgu"** akronim **LORACO (*LOng RAnge COmmunications*)**; projekt realizowany w konsorcjum międzynarodowe: Thales Communications S.A. (lider), OHB Systems AG, Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V. (FKIE), Thales SIX GTS France SAS, Leonardo - Societa Per Azioni, Centro Italiano Ricerche Aerospaziali Scpa, Kongsberg Defence & Aerospace, Centrum Techniki Morskiej S.A. (CTM–OBR), Wojskowy Instytut Łączności–PIB, KenBIT Koenig i Wspólnicy sp. z o.o. sp.j., WAT, Royal Military Academy of Belgium, Rohde&Schwarz Gmbh&Co; **wykonawca**
- **2021–2024 EDA**, EDA Cat. B Project, Contract No. B 1486 IAP4 GP (PUM/09-396/2021/WAT), **„Bezprzewodowe sieci sensorowe do nadzoru lokalnych obszarów miejskich"** akronim **WINLAS (*WIreless sensor Networks for urban Local Areas Surveillance*)**; projekt realizowany w konsorcjum holendersko-polskim: TNO (lider), Thales Nederland, Eindhoven University of Technology, Delft University of Technology, WAT, Wojskowy Instytut Łączności–PIB, ITTI sp. z o.o.; **kierownik projektu**
- **2021–2024 EDA**, EDA Cat. B Project, Contract No. B1520IAP4 GP (PUM/09-234/2021/WAT), **„Taktyczne sieci zdefiniowane programowo"** akronim **SOFTANET (*SOFtware defined TActical and theatre NETwork*)**; projekt realizowany w konsorcjum międzynarodowe; **wykonawca**
- **2023–2027 Narodowe Centrum Badań i Rozwoju (NCBR)**, Umowa nr DOB-SZAFIR/02/A/018/04/2021 (PPFNF/17-165/2023/WAT), **„Mobilny system do zwalczania BSP klasy mikro i mini"** akronim **JERZYK**; projekt realizowany w konsorcjum: WAT (lider), Flytronic S.A., AMZ Kutno S.A.; **wykonawca**
- **2022–2025 NCBR**, Umowa nr DOB-SZAFIR/01/B/029/03/2021 (PPFNF/17-033/2022/ WAT), **„Dowodzenie i kierowanie grupą bezzałogowych statków powietrznych rozpoznania radioelektronicznego COMINT na bazie nowoczesnych technologii IT"** akronim **UAV-COMINT**; projekt realizowany w konsorcjum: WAT (lider), MSP InnTech sp. z o.o.; **kierownik projektu**

- **2022–2026 Narodowe Centrum Nauki (NCN)**, konkurs OPUS 22 LAP, Umowa nr UMO-2021/43/I/ST7/03294, projekt badawczy nr 2021/43/I/ST7/03294 (NCN/07-587/2022/WAT), **„Wielopasmowa predykcja skutków propagacji fal milimetrowych dla scenariuszy dynamicznych i stacjonarnych w trudnych i zmiennych w czasie środowiskach”** akronim **MubaMilWave (*Multi-band prediction of millimeter-wave propagation effects for dynamic and fixed scenarios in rugged time-varying environments*)**; projekt realizowany w konsorcjum międzynarodowym: WAT (lider) oraz Brno University of Technology (Czechy); **kierownik projektu**
- **2022–2025 Ministerstwo Obrony Narodowej (MON)**, Umowa nr 444/2022/DA/GB2 (GBMON/13-985/2022/WAT) **„System taktycznego rozpoznania radiowego z bezzałogowych statków powietrznych”**; **kierownik projektu**
- **2018–2022 MON**, Umowa nr GB/1/2018/205/2018/DA (GBMON/13-996/2018/WAT), **„Badania podstawowe w obszarze technologii sensorowej z wykorzystaniem innowacyjnych metod przetwarzania danych”**; **kierownik grupy zadań**
- **2021–2023 Krajowy Instytut Mediów (KIM)**, (PBU/01-272/2021/WAT) **„Prace badawczo-rozwojowe nad systemem identyfikacji sygnału audio i wideo emitowanego w telewizji i radiu”** akronim **MediaID**; **kierownik projektu**

Działalność publikacyjna
(liczba publikacji, Index Hirscha, informacja z bazy Web of Science, Scopus, najważniejsze publikacje w ostatnich 5 latach)

- Strona prywatna: https://jkelner.com/works-in-progress
- ORCID: https://orcid.org/0000-0002-3902-0784
- Scopus (SC): https://www.scopus.com/authid/detail.uri?origin=resultslist&authorId=25630670100&zone=
- Web of Science (WS): https://www.webofscience.com/wos/author/record/1747948
- Google Scholar (GS): https://scholar.google.com/citations?user=e5NXHBEAAAAJ&hl=pl
- ResearchGate (RG): www.researchgate.net/profile/Jan-Kelner

- Autor i współautor ponad 250 publikacji naukowych
- Recenzent w ponad 30 czasopismach JCR i ponad 20 konferencjach międzynarodowych i krajowych (członek TPC)
- Bibliometria (stan na 2025.10.20):
    - Cytowania publikacji: 1338 (RG), 1288 (GS), 751 (SC), 521 (WS)
    - Index Hirscha: 19 (RG), 18 (GS), 15 (SC), 13 (WS)
    - Sumaryczny współczynnik wpływu (Total Impact Factor): 102.8

Najważniejsze publikacje:

- K. Bednarz, *et al.*: “UAV equipped with SDR-based Doppler localization sensor for positioning tactical radios”, *Drones*, 9(10): 698, 2025, DOI: 10.3390/drones9100698. (IF=4.8, Q1)

- J. Blumenstein, *et al.*: “Stochastic 3D foliage modeling at 80 GHz: Experimental validation and ray tracing simulations”, *IEEE Antennas and Wireless Propagation Letters*, 24(10): 3669–3673, 2025, DOI: 10.1109/LAWP.2025.3600373. (IF=4.8, Q1)
- A. Szczegielniak-Rekiel, *et al.*: “Zero-knowledge proof in 5G and beyond technologies: State of the arts, practical aspects, applications, security issues, open challenges, and future trends”, *IEEE Access*, 13:138352–138380, 2025, DOI: 10.1109/ACCESS.2025.3596122. (IF=3.6, Q2)
- R. Závorka, *et al.*: “Characterizing the 80GHz channel in static scenarios: Diffuse reflection, scattering and transmission through trees under varying weather conditions”, *IEEE Access*, 12:144738–144749, 2024, DOI: 10.1109/ACCESS.2024.3472003. (IF=3.6, Q2)
- N. Singh, *et al.*: “Channel modeling for 60 GHz fixed mmWave O2I and O2O uplink with angular misalignment”, *IEEE Antennas and Wireless Propagation Letters*, 23(5):1653–1657, 2024, DOI: 10.1109/LAWP.2024.3365568. (IF=4.8, Q1)
- P. Skokowski, *et al.*: “Practical trial for low-energy effective jamming on private networks with 5G-NR and NB-IoT radio interfaces”, *IEEE Access*, 12:51523–51535, 2024, DOI: 10.1109/ACCESS.2024.3385630. (IF=3.6, Q2)
- J.M. Kelner, *et al.*: “Modeling UAV swarm flight trajectories using rapidly-exploring random tree algorithm”, *Journal of King Saud University – Computer and Information Sciences*, 36(1):101909, 2024, DOI: 10.1016/j.jksuci.2023.101909. (IF=6.1, Q1)
- J. Mongay Batalla, *et al.*: “On studying active radio measurements estimating the mobile network quality of service for the Regulatory Authority's purposes”, *Computer Networks*, 235:109980, 2023, DOI: 10.1016/j.comnet.2023.109980. (IF=4.4, Q1)
- A. Ghosh, *et al.*: “Vehicle to vehicle path loss modeling at millimeter wave band for crossing cars”, *IEEE Antennas and Wireless Propagation Letters*, 22(9):2125–2129, 2023, DOI: 10.1109/LAWP.2023.3277961. (IF=3.7, Q2)

Działalność dydaktyczna
(prowadzone przedmioty, w tym w SDR, średnia liczba godzin zajęć, w ostatnich 5 latach)

- Prowadzenie wykładów z przedmiotu *Podstawy Telekomunikacji* na kierunkach studiów *Elektronika i Telekomunikacja – profil ogólnoakademicki* (studia pierwszego stopnia inżynierskie – cywilne, jednolite studia magisterskie (JSM) dla MON),
- Prowadzenie wykładów z przedmiotu *Podstawy Telekomunikacji* na kierunkach studiów *Technologie Elektroniczne i Telekomunikacyjne – profil praktyczny* (JSM dla MON)
- Prowadzenie wykładów z przedmiotu *Wprowadzenie do Telekomunikacji* na kierunku *Technologie Przełomowe – profil ogólnoakademicki* (JSM cywilne)
- Prowadzenie przedmiotu *Analiza Obszaru Badawczego* z doktorantami (Szkoła Doktorska WAT)
- Opieka nad doktorantami i dyplomantami
- Średnie obciążenie dydaktyczne w r.a. – około 250–350 h (150–200% pensum)

Osiągnięcia
(nagrody, wyróżnienia, patenty w ostatnich 5 latach)

- Srebrny Krzyż Zasługi (2025)
- Medal Komisji Edukacji Narodowej (2019)
- Srebrny Medal za Zasługi dla WAT (2019)
- Nagroda Rektora WAT za zespołowe osiągnięcie naukowe – realizację grantu EDA „Bezprzewodowe sieci sensorowe do nadzoru lokalnych obszarów miejskich” akronim WINLAS (2025)
- Nagroda Rektora WAT za zespołowe osiągnięcie organizacyjne – organizację XIII Konferencji Naukowo-Technicznej Systemy Rozpoznania i Walki Radioelektronicznej (2025)
- Nagroda Rektora WAT za zespołowe osiągnięcie naukowe – realizację grantu EDA „Taktyczne sieci zdefiniowane programowo” akronim SOFTANET (2024)
- Nagroda Rektora WAT za zespołowe osiągnięcie organizacyjne – rozwijanie współpracy Sił Zbrojnych RP z otoczeniem społeczno-gospodarczym (2024)
- Nagroda Rektora WAT za indywidualne osiągnięcie naukowe – cykl publikacji będący podstawą nadania stopnia naukowego doktora habilitowanego (2021)
- Nagroda Rektora WAT za indywidualne osiągnięcie naukowe – rozprawę doktorską (2011)
- Stypendium publikacyjne Rektora WAT (2017–2025)

Doświadczenie w pracy promotorskiej i recenzenckiej
(liczba wypromowanych doktorów, liczba recenzji: doktorantów, w postępowaniach habilitacyjnych, opinie w postępowaniach profesorskich, w ostatnich 5 latach)

- Promotor pomocniczy w dwóch obronionych przewodach doktorskich, w tym jeden – z wyróżnieniem (nagrodzony także tytułem Innowatora Mazowsza)
- Promotor 11 doktorantów w Szkole Doktorskiej WAT i 1 doktoranta eksternistycznego
- Recenzje postępowań habilitacyjnych – 2
- Recenzje przewodów doktorskich – 2

Dane kontaktowe

Miejsce pracy: nr budynku/nr pokoju: 45 / 114
Tel.: 261 839 050
Email: jan.kelner@wat.edu.pl

Uwaga: nie więcej niż 4 strony, w razie pytań i uwag proszę o kontakt: piotr.zalewski@wat.edu.pl tel. 603 889 905

Wizytówka naukowa pracownika WAT

Tytuł/stopień naukowy Imię i Nazwisko, Nr ORCID

Dr hab. inż. Andrzej Najgebauer, prof. WAT, Nr ORCID: 0000-0002-4268-8697

Stanowisko, funkcja kierownicza

Profesor n-d uczelni, kierownik zakładu badań operacyjnych i wspomagania decyzji

Reprezentowana dyscyplina naukowa (dyscypliny naukowe %)

Informatyka techniczna i telekomunikacja

Obszar zainteresowań naukowych

Systemy wspomagania decyzji, sztuczna inteligencja, modelowanie i symulacja, modelowanie sytuacji konfliktowych i kryzysowych

Działalność organizacyjna
(udział w pracach różnych gremiów, pełnione funkcje, w ostatnich 5 latach)

1. Kierownik zakładu badań operacyjnych i wspomagania decyzji
2. Kierownik zespołu interdyscyplinarnego modelowania, symulacji i informatycznego wspomagania decyzji w sytuacjach konfliktowych i kryzysowych
3. Senator WAT
4. Członek rady dyscypliny naukowej informatyka techniczna i telekomunikacja
5. Polski, główny przedstawiciel z prawem głosu w panelu NATO Science and Technology Organization – NATO Modelling and Simulation Group (NMSG)
6. Członek komitetu naukowego corocznego sympozjum Panelu NMSG.
7. Członek komitetu naukowego dorocznej europejskiej konferencji: European Simulation Multiconference (ESM)
8. Współprzewodniczący konferencji amerykańskiej MilCom 2025 WS-03 - Workshop on Disruptive and Enabling Technologies for NATO and other Coalition Operations
9. Wiceprezes Polskiego Towarzystwa Symulacji Komputerowej
10. Organizator dwóch gier wojennych w ramach inicjatywy dowództwa NATO Allied Command Transformation pn. Innovation Continuum 2024 i Innovation Continuum 2025

Działalność badawcza
(udział w programach, projektach, grantach, sposób finansowania, w ostatnich 5 latach)

1. Projekt AIDA – Artificial Intelligence Deployable Agent – Projekt European Defence Fund 2024 – **Kierownik projektu** z ramienia WAT w konsorcjum międzynarodowym. (2024-2028) – finansowanie Unii Europejskiej
2. Projekt NATO Innovation Continuum Allied Command Transformation 2024 Wargame for Collective Defence Planning Process of EDT Supported MDO – gra wojenna dla potrzeb analizy wpływu najnowszych technologii (sztucznej inteligencji, obliczeń kwantowych, technologii kosmicznych, dronowych, walki radioelektronicznej) na przebieg działań wojennych – testowanie artykułu V Traktatu Waszyngtońskiego. – **kierownik gry**. Finansowanie NATO ACT i WAT
3. Projekt NATO Innovation Continuum Allied Command Transformation 2025 - Wargame for Computational Intelligence in MDO supported by EDT – gra wojenna dla potrzeb analizy wpływu najnowszych technologii na konlikty

zbrojne w kontekście zmniejszenia niepewności i oceny efektywności technologii (koszt/efekt) a także struktur dowodzenia operacjami wielodomenowymi - **kierownik gry**. Finansowanie NATO ACT i WAT

4. **Kierowanie projektem RCB -** Um. RCB nr 16/2021 -Opracowanie metodyki oceny ryzyka oraz analizy usług i procesów realizowanych przez operatorów Infrastruktury Krytycznej (IK) - 2021-22 realizowany ze środków finansowych Funduszu Bezpieczeństwa Wewnętrznego (p. f. nr 88/PL/2020/FBW z dn. 23.06.2020 r.

Działalność publikacyjna

(liczba publikacji, Index Hirscha, informacja z bazy Web of Science, Scopus, najważniejsze publikacje w ostatnich 5 latach)

Ponad 140 publikacji naukowych , h-indeks 10

1. A. Najgebauer : Consideration of electronic warfare in the assessment and development of the operational capabilities of the armed forces. IET Radar Sonar Navig. 18(11), 2199–2211 (2024). https://doi.org/10.1049/rsn2.12629,
2. A. Najgebauer, Simulation Based Acquisition- Polish Concepts and Tools, © 2023 EUROSIS-ETI, ESM'2023, ISBN: 978-9-492-859-28-0,
3. A. Najgebauer, D. Maślanik, Simulation and Computational Intelligence Methods for Combat Groupings Operational Capabilities Analysis in Cross-Domain Operations, © 2023 EUROSIS-ETI, ESM'2023, ISBN: 978-9-492-859-28-0,
4. A. Najgebauer, S. Wojciechowski, R. Antkiewicz, D. Pierzchała – ch. 6. Simulation and Artificial Intelligence Methods for Wargames: Case study- "European Thread" ,in Simulation and Wargaming, C.Turnitsa, C.A.Blais, A.Tolk eds.,2022 John Wiley&Sons, Inc. ISBN 978-1-119-60478-5,
5. A. Najgebauer, R. Antkiewicz, Modelling Operators of Critical Infrastructures in order to Risk and Continuity of Services Analysis, © 2022 EUROSIS-ETI, ESM'2022, ISBN: 978-9-492-859-24-2,
6. A. Najgebauer, R. Antkiewicz, D. Pierzchała, T. Gutowski, P. Czuba, Simulation Based Risk and Continuity of Services Analysis – A Case Study of Power Transmission, © 2022 EUROSIS-ETI, ESM'2022, ISBN: 978-9-492-859-24-2,
7. A. Najgebauer, R. Antkiewicz, D. Maślanik, Strategic Wargame Toolset for the Investigation of Emerging Disruptive Technologies Impact in Multidomain Operations, ESM®'2024, EUROSIS-ETI Publication, ISBN: 978-9-492-859-33-4, EAN: 9789492859334

Działalność dydaktyczna

(prowadzone przedmioty, w tym w SDR, średnia liczba godzin zajęć, w ostatnich 5 latach)

1. Podstawy symulacji komputerowej
2. Metody i narzędzia wspomagania decyzji
3. Sztuczna inteligencja
4. Metody sztucznej inteligencji
5. Metody inteligencji obliczeniowej
6. Systemy wspomagania decyzji
7. Modelowanie i symulacja pola walki
8. Sztuczna inteligencja III
9. Systemy wspomagania decyzji III
10. Symulacja komputerowa III
11. Metody i systemy wspomagania dowodzenia
12. Teoria decyzji statystycznych

Średnia liczba godzin zajęć w roku akademickim: 335 h

Osiągnięcia
(nagrody, wyróżnienia, patenty w ostatnich 5 latach)

Nagroda Rektorska 2025 za przygotowanie i przeprowadzenie eksperymentu w postaci gry wojennej, pod nazwą „Wargame for collective defence planning process of EDT supported MDO"

Wyróżnienie z NATO ACT:

"Special recognition is extended to Prof. Andrzej Najgebauer, who organized and conducted the Collective Defence wargame. The performance of Prof. Najgebauer was truly remarkable and greatly enhanced the impact of Innovation Continuum 2024 on advancing development of Emerging and Disruptive Technologies for Warfare Development" - HQ Supreme Allied Commander Transformation Division of Requirements, Thorsten L. Jorgensen, Brigadier General, DNK Army ACOS Requirements.

Doświadczenie w pracy promotorskiej i recenzenckiej
(liczba wypromowanych doktorów, liczba recenzji: doktorantów, w postępowaniach habilitacyjnych, opinie w postępowaniach profesorskich, w ostatnich 5 latach)

Liczba wypromowanych doktorów: 11

Liczba recenzji doktorantów: 11

Liczba recenzji w postępowaniach habilitacyjnych: 4

Dane kontaktowe

Miejsce pracy: nr budynku/nr pokoju: 244

Tel.:533025031

Email: andrzej.najgebauer@wat.edu.pl

Uwaga: nie więcej niż 4 strony, w razie pytań i uwag proszę o kontakt: piotr.zalewski@wat.edu.pl tel. 603 889 905

Wizytówka naukowa pracownika WAT

Tytuł/stopień naukowy Imię i Nazwisko, Nr ORCID

dr hab. inż. Tadeusz Nowicki, prof. WAT, ORCID 0000-0003-3195-9399

Stanowisko, funkcja kierownicza

Dyr. Instytutu Systemów Informatycznych, Wydział Cybernetyki WAT

Reprezentowana dyscyplina naukowa (dyscypliny naukowe %)

Informatyka Techniczna i Telekomunikacja (100%)

Obszar zainteresowań naukowych

Modelowanie matematyczne, teoria optymalizacji, teoria niezawodności i eksploatacji, symulacja komputerowa, procesy biznesowe, modele stochastyczne

Działalność organizacyjna
(udział w pracach różnych gremiów, pełnione funkcje, w ostatnich 5 latach)

Prezes Polskiego Towarzystwa Symulacji Komputerowej, członek Rady Naukowej WICHiE, ekspert PKA i KAUT, Członek rady dyscypliny ITiT WCY WAT, członek Senatu WAT, Członek Komisji WAT ds. własności intelektualnej, członek EuroSim Board

Działalność badawcza
(udział w programach, projektach, grantach, sposób finansowania, w ostatnich 5 latach)

1. **(2017-2019) kierowanie z ramienia WAT projektu** współfinansowanego z Europejskiego Funduszu Rozwoju Regionalnego w ramach Osi Priorytetowej I „Wykorzystanie działalności badawczo-rozwojowej w gospodarce" Działania 1.2 „Działalność badawczo-rozwojowa przedsiębiorstw" regionalnego programu operacyjnego województwa mazowieckiego na lata 2014-2020, pt. Opracowanie inteligentnego systemu zarządzania procesami biznesowymi z uwzględnieniem rozwiązań inteligentnych systemów wspierających integrację tradycyjnych oraz elektronicznych kanałów sprzedaży w rentalu odzieży roboczej (sektor B2B). Umowa numer: RPMA.01.02.00-14-5748/16-00
2. **(2018-2020)** zastępca kierownika merytorycznego projektu i wykonawca w ramach projektu finansowanego przez NCBiR projektu POIR.01.01.01-00-1146/17-00 pt. „Opracowanie i badanie własności nowych metod i technik optymalizacji procesów dystrybucji towarów i usług"
3. **(2018-2019)** wykonawca w projekcie badawczo-rozwojowym pt. POIR.02.03.02-IP.03-00-001/17 „DietByMed - interaktywna platforma medyczna oparta na zasadach EBD (Evidence Based Medicine) wspomagająca pracę dietetyka" realizowany zgodnie z Programem Operacyjnym Inteligentny Rozwój, oś priorytetowa 2 - Wsparcie otoczenia i potencjału przedsiębiorstw do prowadzenia działalności B+R+I, działanie 2.3 - Proinnowacyjne usługi dla przedsiębiorstw, poddziałanie 2.3.2 - Bony na innowacje
4. **(2021-2024)** Praca badawcza UGB Modele, metody i środowiska technologiczne w zagadnieniach wytwarzania, utrzymania, pielęgnacji i integracji systemów informatycznych we wspomaganiu bezpieczeństwa i Cyber bezpieczeństwa państwa, realizowany w latach 2021-2024 (finansowanie MON, WAT).

Działalność publikacyjna
(liczba publikacji, Index Hirscha, informacja z bazy Web of Science, Scopus, najważniejsze publikacje w ostatnich 5 latach)

Index Hirscha Web of Science 6,

1. Nowicki T., Saniuk A., Waszkowski R. (2019) *Clothing distribution optimization for the rental company warehouse*. In. Advances in Social and Occupational Ergonomics,

Springer International Publishing AG, part of Springer Nature, (2019), R. H. M. Goossens (Ed.): AHFE 2018, AISC 792, pp. 1–12, 2019, https://doi.org/10.1007/978-3-319-94000-7_39
2. Nowicki T., Waszkowski R. (2019) *Modeling and characteristics investigation of warehouse business processes in a clothes clean&rental company*. 1th International Conference on Optimization Driven Architectural Design OPTARCH 2019, 5-7 November 2019, Amman, Jordan,
3. Nowicki T., Waszkowski R. (2019) *Efficiency investigation and optimization of contract management business processes in a workwear rental and laundry service company*. 1th International Conference on Optimization Driven Architectural Design OPTARCH 2019, 5-7 November 2019, Amman, Jordan, Procedia Manufacturing, Volume 44, 2020, Pages 551-558
4. Tarapata Z., Nowicki T., Antkiewicz R., Dudziński J., Janik K. (2019) *Data-Driven Machine Learning System for Optimization of Processes Supporting the Distribution of Goods and Services - a case study*. 1th International Conference on Optimization Driven Architectural Design OPTARCH 2019, 5-7 November 2019, Amman, Jordan, Procedia Manufacturing, Volume 44, 2020, Page s 60-67
5. Nowicki T., Cąkała M. (2019) *Modelowanie i optymalizacja rozmieszczenia odzieży w magazynie firmy typu Clothes Rental&Washing*, rozdział monografii Systemy informatyczne na potrzeby bezpieczeństwa państwa oraz gospodarki narodowej. Modele i metody. wyd. Wojskowa Akademia Techniczna (red. Z. Tarapata), str. 99-114, ISBN 978-83-7938-257-6
6. Nowicki T., Woźniak A. (2019) *Modelowanie i optymalizacja Architektury systemów zorientowanych na usługi, rozdział monografii Systemy informatyczne na potrzeby bezpieczeństwa państwa oraz gospodarki narodowej. Modele i metody*. wyd. Wojskowa Akademia Techniczna (red. Z. Tarapata), str. 115-130, ISBN 978-83-7938-257-6
7. Nowicki T., Woźniak A. (2019) *Modelowanie i badanie efektywności funkcjonowania firmy klasy Clothes Rental&Washing*, rozdział monografii Systemy informatyczne na potrzeby bezpieczeństwa państwa oraz gospodarki narodowej. Zastosowania. wyd. Wojskowa Akademia Techniczna (red. Z. Tarapata), str. 115-130, ISBN 978-83-7938-256-9
8. Tarapata Z., Nowicki T., Antkiewicz R., Dudziński J., Janik K. (2019) *Koncepcja opartego na wiedzy systemu informatycznego zwiększającego efektywność procesu wspomagania dystrybucji towarów i usług: studium przypadku*, w: Tarapata Z. (red.): Systemy informatyczne na potrzeby bezpieczeństwa państwa oraz gospodarki narodowej: zastosowania, ISBN 978-83-7938-256-9, Wojskowa Akademia Techniczna, Warszawa, 2019, str. 119-134
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14. Nowicki T., Waszkowski R. (2020) *Symulacyjne badanie efektywności funkcjonowania przedsiębiorstwa serwisującego odzież roboczą*, Sosnowski Zenon A. (eds.): Symulacje komputerowe w badaniach i rozwoju, 2020, Oficyna Wydawnicza Politechniki Białostockiej, str. 171-191, ISBN 978-83-66391-27-7, DOI:10.24427/978-83-66391-28-4
15. Nowicki T., Matuszelański Ł. (2021) *Mathematical Modeling and Virtual Simulation in Optimizing the Location of Equipment on Fire-fighting Vehicle*, 37th IBIMA Conference: 30-31 May 2021, Cordoba, Spain, https://ibima.org/accepted-paper/mathematical-modeling-and-virtual-simulation-in-optimizing-the-location-of-equipment-on-fire-fighting-vehicle/
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19. Chodowska-Wasilewska A., Nowicki T., Waszkowski, R., (2022). *Designing and Implementing Simulation Exercises for State Sanitary and Epidemiological Service*, Production Management and Process Control, Vol. 36, 2022, 171–177, Published by AHFE Open Access, https://doi.org/10.54941/ahfe1001632
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Conference on Software Engineering, 26-27 June 2023 Granada, Spain, https://ibima.org/accepted-paper/modelling-simulation-and-analysis-of-the-leave-management-process-implemented-in-a-low-code-development-platform/

24. Nowicki T., Pieczonka P. (2023). *Simulated method for determining the strategy for the anti-epidemic control of selected objects*, 41st IBIMA Computer Science Conference, 26-27 June 2023 Granada, Spain, https://ibima.org/accepted-paper/simulation-method-for-determining-the-strategy-for-the-anti-epidemic-control-of-selected-objects/
25. Nowicki T., Sobolewski M. (2023). *Genetic algorithm for determining optimal scheduling of epidemic interviews*, 41st IBIMA Computer Science Conference, 26-27 June 2023 Granada, Spain https://ibima.org/accepted-paper/genetic-algorithm-for-determining-optimal-scheduling-of-epidemic-interviews/
26. Nowicki T., Pieczonka P., Sobolewski M. (2023). *Decision Support Analysis in Food-borne Epidemics*, 42nd IBIMA Conference, 29-30 November 2023, Seville, Spain, https://ibima.org/accepted-paper/decision-support-analysis-in-food-borne-epidemics/
27. Nowicki T., Pieczonka P., Sobolewski M. (2023). *Components Implementation and Integration for Decision Support in Food-borne Decease Epidemy*, 42nd IBIMA Conference, 29-30 November 2023, Seville, Spain, https://ibima.org/accepted-paper/components-implementation-and-integration-for-decision-support-in-food-borne-decease-epidemy/
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29. Nowicki T., Waszkowski, R., (2023). *Low-Code Development Platform for Modeling and Implementation of Business Processes to Support Outbreak Investigations*, Application of Emerging Technologies, Vol. 115, 2023, 294–302, Published by AHFE Open Access, https://doi.org/10.54941/ahfe1004326
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32. Nowicki T., Pieczonka P., Sobolewski M., Waszkowski R., (2024). *Optimizing Delivery Routes with Spatially Distributed Orders*, 43nd IBIMA Computer Science Conference, 26-27 June 2024, Madrid, Spain, https://ibima.org/accepted-paper/optimizing-delivery-routes-with-spatially-distributed-orders/
33. Nowicki T., Pieczonka P., Sobolewski M., Waszkowski R., (2024). *Investigating the Role of Initial Population Seeding on Convergence and Solution Quality in Genetic Algorithms*, 43nd IBIMA Computer Science Conference, 26-27 June 2024, Madrid, Spain, https://ibima.org/accepted-paper/components-implementation-and-integration-for-decision-support-in-food-borne-decease-epidemy/
34. Nowicki, T., Waszkowski, R. (2024). Models and Methods in Crisis Management Connected with Food-Borne Disease Outbreak. In: Saeed, K., Dvorský, J. (eds) Computer Information Systems and Industrial Management. CISIM 2024. Lecture Notes in Computer Science, vol 14902, pp 401–413. Springer, Cham. https://doi.org/10.1007/978-3-031-71115-2_28

35. Nowicki T., Waszkowski R., *Optimizing contract flow: A simulation-based approach to efficiency improvement*, 15th International Conference on Applied Human Factors and Ergonomics (AHFE 2024), Université Côte d'Azur, 24-27 July, 2024, Nice, France
36. Nowicki T., Panufnik K., (2024). *Mathematical model of communication of multiple simulators in an environment based on the HLA standard*, 44th IBIMA Computer Science Conference, 27-28 November 2024, Granada Spain, https://ibima.org/accepted-paper/mathematical-model-of-communication-of-multiple-simulators-in-an-environment-based-on-the-hla-standard-protocol/
37. Nowicki T., Stolarski K., *Algorytm genetyczny do rozwiązywania zadania szeregowania z ograniczeniami czasowymi*, Innowacje w elektronice, informatyce i inżynierii produkcji - Tom 5, monografia nr 439 Wydział Elektroniki i Informatyki, Politechnika Koszalińska, Koszalin 2025, ISSN 0239-7129
38. Nowicki T., Wróblewski S., *Algorytm genetyczny do rozwiązywania zadania rozmieszczenia*, Innowacje w elektronice, informatyce i inżynierii produkcji - Tom 5, monografia nr 439 Wydział Elektroniki i Informatyki, Politechnika Koszalińska, Koszalin 2025, ISSN 0239-7129
39. Burzyński R., Nowicki T., Waszkowski R. (2025). *Genetic Algorithm for Solving a Scheduling Problem*. In: Borowik, G., Chmaj, G., Waszkowski, R. (eds) Models and Methods for Systems Engineering. Studies in Big Data, vol 165. Springer, Cham. https://doi.org/10.1007/978-3-031-76440-0_14
40. Nowicki T., Panufnik K., (2025). *Method for selecting strategy of communication of multiple simulators in an environment based on the HLA standard*, 45th IBIMA Computer Science Conference, 25-26 June 2025, Cordoba Spain, in (ed. Khalid S. Soliman) Advancements in Artificial Intelligence and Computer Security in Modern Computing, ISBN: 979-8-9867719-7-7, https://ibima.org/accepted-paper/method-for-selecting-strategy-of-communication-of-multiple-simulators-in-an-environment-based-on-the-hla-standard/
41. Nowicki T., Oleś-Filiks M., Warchulska A., (2025). *Modeling Business Processes for Heat Pump Sales and Configuration: A Low-Code Platform Approach*, 45th IBIMA Business Conference, 25-26 June 2025, Cordoba Spain, in (ed. Khalid S. Soliman) Strategies, Innovation, and Human-Centric Practices in the Modern Organizations, ISBN: 979-8-9867719-6-0, https://ibima.org/accepted-paper/modeling-business-processes-for-heat-pump-sales-and-configuration-a-low-code-platform-approach/
42. Nowicki T., Waszkowski R., Warchulska A., *Modeling, simulation and analysis of invoices flow in Low-code platform*. Proceedings of the 2025 Winter Simulation Conference, December 7-10, 2025, Seattle, USA

Działalność dydaktyczna

(prowadzone przedmioty, w tym w SDR, średnia liczba godzin zajęć, w ostatnich 5 latach)

W szkole doktorskiej:
Optymalizacja III, Niezawodność systemów III, Modelowanie symulacja i analiza procesów biznesowych III, stochastyczne modele eksploatacji III
Średnia liczba godzin rocznie za ostatnie 5 lat: 40 godzin

Osiągnięcia

(nagrody, wyróżnienia, patenty w ostatnich 5 latach)

Defender (2029) - Nagroda Ministra Obrony Narodowej za Budowę pojazdów pożarniczych z zachowaniem ergonomii użytkowania, nagrodzeni z Wydziału Cybernetyki: prof. Andrzej Walczak, dr hab. inż. Tadeusz Nowicki, dr inż. Jarosław Koszela, dr inż. Roman Wantoch-Rekowski, mgr inż. Łukasz Matuszelański

Doświadczenie w pracy promotorskiej i recenzenckiej

(liczba wypromowanych doktorów, liczba recenzji: doktorantów, w postępowaniach habilitacyjnych, opinie w postępowaniach profesorskich, w ostatnich 5 latach)

Promotor rozpraw doktorskich (5 ostatnich lat)

1. dr inż. Adrian Woźniak - *Metoda efektywnego rozmieszczania komponentów oraz sterowania ich obciążeniem w systemach klasy SOA*, rozprawa doktorska, Wydział Cybernetyki WAT, Warszawa 9.03.2021
2. mgr inż. Joanna Szkutnik-Rogoż - *Komputerowe wspomaganie modelowania i optymalizacji strategii postępowania w wybranych problemach, w tym niezawodnościowych, w systemach transportowych* (Szkoła Doktorska WAT), rozprawa doktorska, Wydział Cybernetyki WAT, Warszawa 14.01.2025
3. mgr inż. Marcin Pery - *Metoda steganografii wideo odporna na zniekształcenia analogowe* rozprawa doktorska, Wydział Cybernetyki WAT, Warszawa 8.07.2025

Rozprawy habilitacyjne:

1. Recenzja wydawnicza rozprawy habilitacyjnej dr. inż. Piotra Kisielewskiego pt. „Komputerowe wspomaganie planowania w komunikacji miejskiej", dla Politechniki Warszawskiej, 2019
2. Członek komisji habilitacyjnej i jednocześnie sekretarz tej komisji powołanej w celu przeprowadzenia procedury habilitacyjnej dr. inż. Janusza Furtaka z Wojskowej Akademii Technicznej, WAT 2020
3. Członek komisji habilitacyjnej i jednocześnie sekretarz tej komisji powołanej w celu przeprowadzenia procedury habilitacyjnej dr. inż. Grzegorza Borowika z Wyższej Szkole Policji w Szczytnie, WAT 2020
4. Członek komisji habilitacyjnej i jednocześnie sekretarz tej komisji powołanej w celu przeprowadzenia procedury habilitacyjnej dr. inż. Dominika Strzałki, WAT 2022-2023
5. Członek komisji habilitacyjnej i jednocześnie sekretarz tej komisji powołanej w celu przeprowadzenia procedury habilitacyjnej dr. inż. Michała Wrońskiego, WAT 2025

Recenzje rozpraw doktorskich:

1. Recenzja rozprawy doktorskiej mgr. inż. Sławomira Bąka pt. "Synteza rozproszonych aplikacji czasu rzeczywistego przetwarzanych w chmurze obliczeniowej", Politechnika Warszawska, 2019
2. Recenzja rozprawy doktorskiej mgr. inż. Piotra Dryji pt. „Optymalizacja zasobów chmury obliczeniowej z wykorzystaniem inteligentnych agentów w zdalnym nauczaniu", Politechnika Gdańska, 2023

Dane kontaktowe

Miejsce pracy: nr budynku/nr pokoju: bud 100, pok. 222 oraz pok. 225a

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Wizytówka naukowa pracownika WAT

Tytuł/stopień naukowy Imię i Nazwisko, Nr ORCID

Dr hab. inż. Zbigniew Piotrowski, ORCID: 0000-0003-3556-0297

Stanowisko, funkcja kierownicza

Profesor WAT

Reprezentowana dyscyplina naukowa (dyscypliny naukowe %)

Informatyka Techniczna i Telekomunikacja

Obszar zainteresowań naukowych

Cyfrowe przetwarzanie sygnałów, sztuczna inteligencja, radiokomunikacja, multimedia

Działalność organizacyjna
(udział w pracach różnych gremiów, pełnione funkcje, w ostatnich 5 latach)

Sekretarz Komitetu Elektroniki i Telekomunikacji Polskiej Akademii Nauk
Ekspert Komitetu Elektroniki i Telekomunikacji Polskiej Akademii Nauk
Członek Stowarzyszenia Elektryków Polskich
Członek Polskiego Towarzystwa Akustycznego
Redaktor naczelny czasopisma „*Elektronika – konstrukcje, technologie, zastosowania*”
Redaktor naczelny czasopisma „*Przegląd telekomunikacyjny – wiadomości telekomunikacyjne*”.

Działalność badawcza
(udział w programach, projektach, grantach, sposób finansowania, w ostatnich 5 latach)

- 2021–2024 EDA Cat. B Project, Contract No. B1520IAP4 GP (PUM/09-234/2021/WAT), „Taktyczne sieci zdefiniowane programowo” kr. SOFTANET (SOFtware defined TAktical and theatre NETwork);
- 2022–2025 EDA Cat. B Project, Contract No. B.PRJ.RT.978 (PUM/09-339/2022/WAT), „Łączność i systemy radarowe wzmocnione sztuczną inteligencją w warunkach wojny elektronicznej” kr. CRAI 1 (Communications and Radar systems hardened with Artificial Intelligence in a contested electronic warfare environment);
- 2022–2025 EDA Cat. B Project, Contract No. B.PRJ.RT.832 (PUM/09-027/2022/WAT), “Łączność dalekiego zasięgu” kr. LoRaCo (Long Range Communications);
- 2018–2021 NCBiR, Umowa nr CYBERSECIDENT/381319/II/NCBR/2018 (PPFNF/17-221/2018/ WAT) „Federacyjny system wykrywania i reagowania na zagrożenia w cyberprzestrzeni” kr. DETRES;
- 2018–2021 NCBiR, Umowa nr DOB-BIO9/19/01/2018 (PPFNF/17-493/2018/WAT), „Zaawansowana analiza zasobów Internetu wspomagająca wykrywanie grup przestępczych” kr. AIsearcher;
- 2018–2022 NCBiR, Umowa nr DOB-BIO9/29/04/2018 (PPFNF/17-486/2018/WAT), „Szerokopasmowy rejestrator radiokomunikacyjny” kr. Szerszeń;
- 2018–2022 NCBiR, Umowa nr DOB-BIO10/05/03/2019 (PPFNF/17-318/2018/WAT), „Teleinformatyczny moduł wspomagania identyfikacji ofiar katastrof i ataków terrorystycznych” kr. IDVictim;
- 2021–2024 NCBiR, Umowa nr DOB-SZAFIR /05/A/027/01/2021 (PPFNF/17-205/2021/WAT), „Opracowanie technologii transmisji danych i budowa Modemu MF-TDMA do bezpiecznego i niezawodnego przesyłania danych w systemach łączności VSAT” kr. SatBIT;
- 2021 WAT (UGB/22-854/2021/WAT), „Aplikacje wybranych technik informatyki, łączności i rozpoznania w obszarach cywilnych i wojskowych”;

- 2022 WAT (UGB/22-742/2022/WAT), „Metody osadzania i ekstrakcji znaku wodnego oraz metody agregacji i analizy widmowej z wykorzystaniem sieci neuronowych";
- 2023 WAT (UGB/22-864/2023/WAT), „Metody osadzania i ekstrakcji znaku wodnego oraz metody agregacji i analizy widmowej z wykorzystaniem sieci neuronowych";
- 2025 WAT (UGB/22-052/2025/WAT), „Nowe architektury sieci neuronowych do przetwarzania sygnałów i danych w radiokomunikacji i multimediach";

Działalność publikacyjna

(liczba publikacji, Index Hirscha, informacja z bazy Web of Science, Scopus, najważniejsze publikacje w ostatnich 5 latach)

Ponad 200 publikacji od roku 1996 do chwili obecnej, w tym 59 publikacji z listy JCR, (26 publikacji z listy JCR w ostatnich pięciu latach tj. 2021-2025), Web of Science (WoS) h=13, Research Gate (h=16), Scopus (h=15).

Artificial Intelligence Applications in Military Systems and Their Influence on Sense of Security of Citizens	Bistron, Marta; Piotrowski, Zbigniew	ELECTRONICS	APR 2021	10.3390/electronics10070871
A Survey of Sound Source Localization and Detection Methods and Their Applications	Jekaterynczuk, Gabriel; Piotrowski, Zbigniew	SENSORS	JAN 2024	10.3390/s24010068
Overview of Voice Conversion Methods Based on Deep Learning	Walczyna, Tomasz; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	MAR 2023	10.3390/app13053100
A Wireless Covert Channel Based on Dirty Constellation with Phase Drift	Grzesiak, Krystian; Piotrowski, Zbigniew; Kelner, Jan M.	ELECTRONICS	MAR 2021	10.3390/electronics10060647
High-Quality Video Watermarking Based on Deep Neural Networks and Adjustable Subsquares Properties Algorithm	Kaczynski, Maciej; Piotrowski, Zbigniew	SENSORS	JUL 2022	10.3390/s22145376
An Adaptive Energy Saving Algorithm for an RSSI-Based Localization System in Mobile Radio Sensors	Olesinski, Adam; Piotrowski, Zbigniew	SENSORS	JUN 2021	10.3390/s21123987
Comparison of Machine Learning Algorithms Used for Skin Cancer Diagnosis	Bistroń, Marta; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	OCT 2022	10.3390/app12199960
Efficient Video Watermarking Algorithm Based on Convolutional Neural Networks with Entropy-Based Information Mapper	Bistron, Marta; Piotrowski, Zbigniew	ENTROPY	FEB 2023	10.3390/e25020284
Quick Overview of Face Swap Deep Fakes	Walczyna, Tomasz; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	MAY 31 2023	10.3390/app13116711
A Radio Frequency Region-of-Interest Convolutional Neural Network for Wideband Spectrum Sensing	Olesinski, Adam; Piotrowski, Zbigniew	SENSORS	JUL 2023	10.3390/s23146480
High-Quality Video Watermarking Based on Deep Neural Networks for Video with HEVC Compression	Kaczynski, Maciej; Piotrowski, Zbigniew; Pietrow, Dymitr	SENSORS	OCT 2022	10.3390/s22197552
StegoFrameOrder-MAC Layer Covert Network Channel for Wireless IEEE 802.11 Networks	Sawicki, Krzysztof; Bieszczad, Grzegorz; Piotrowski, Zbigniew	SENSORS	SEP 2021	10.3390/s21186268
Fast Fake: Easy-to-Train Face Swap Model	Walczyna, Tomasz; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	MAR 2024	10.3390/app14052149
Enhancing Web Application Security: Advanced Biometric Voice Verification for Two-Factor Authentication	Kaminski, Kamil Adam; Dobrowolski, Andrzej Piotr; Piotrowski, Zbigniew; Scibiorek, Przemyslaw	ELECTRONICS	SEP 2023	10.3390/electronics12183791
From Constellation Dithering to NOMA Multiple Access: Security in Wireless Systems	Grzesiak, Krystian; Piotrowski, Zbigniew	SENSORS	APR 2021	10.3390/s21082752
Optimization of Imaging Reconnaissance Systems Using Super-Resolution: Efficiency Analysis in Interference Conditions	Bistron, Marta; Piotrowski, Zbigniew	SENSORS	DEC 2024	10.3390/s24247977
Detection of Manipulations in Digital Images: A Review of Passive and Active Methods Utilizing Deep Learning	Duszejko, Pawel; Walczyna, Tomasz; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	JAN 2025	10.3390/app15020881
UaVirBASE: A Public-Access Unmanned Aerial Vehicle Sound Source Localization Dataset	Jekaterynczuk, Gabriel; Szadkowski, Rafal; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	MAY 12 2025	10.3390/app15105378
Victim Verification with the Use of Deep Metric Learning in DVI System Supported by Mobile Application	Piotrowski, Zbigniew; Bistron, Marta; Jekaterynczuk, Gabriel; Kaczmarek, Pawel; Pietrow, Dymitr	APPLIED SCIENCES-BASEL	JAN 2025	10.3390/app15020727

Detecting Malicious Devices in IPSEC Traffic with IPv4 Steganography	Jekaterynczuk, Gabriel; Jankowski, Damian; Veyland, Rene; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	MAY 2024	10.3390/app14093934
Clustering Method for Signals in the Wideband RF Spectrum Using Semi-Supervised Deep Contrastive Learning	Olesinski, Adam; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	APR 2024	10.3390/app14072990
Covert Channel Based on Quasi-Orthogonal Coding	Grzesiak, Krystian; Piotrowski, Zbigniew; Kelner, Jan M. M.	ELECTRONICS	MAY 15 2023	10.3390/electronics12102249
NN-Based 8FSK Demodulator for the Covert Channel	Grzesiak, Krystian; Piotrowski, Zbigniew	SENSORS	OCT 2022	10.3390/s22197181
4KSecure: A Universal Method for Active Manipulation Detection in Images of Any Resolution	Duszejko, Pawel; Piotrowski, Zbigniew	APPLIED SCIENCES-BASEL	APR 18 2025	10.3390/app15084469
Change and Detection of Emotions Expressed on People's Faces in Photos	Piotrowski, Zbigniew; Kaczynski, Maciej; Walczyna, Tomasz	APPLIED SCIENCES-BASEL	NOV 2024	10.3390/app142210681
Synchronization of Acoustic Signals for Steganographic Transmission	Wojtun, Jaroslaw; Piotrowski, Zbigniew	SENSORS	MAY 2021	10.3390/s21103379

Działalność dydaktyczna

(prowadzone przedmioty, w tym w SDR, średnia liczba godzin zajęć, w ostatnich 5 latach)

Technika Ukrywania Informacji (SDR) 30 godz.
Wojskowe systemy łączności i informatyki (WEL) 6 godziny
Stacjonarny polowy system łączności i informatyki (WEL) 6 godzin
Analiza Sygnałów (WEL) 48 godzin
Narzędzia Pracy Zespołowej (WEL) 22 godzin
Techniki steganografii sieciowej (WEL) 10 godzin
Acoustic Singla Processing (Erasmus) 20 godzin
Aplikacje Uczenia głębokiego (WEL) 16 godzin

Osiągnięcia

(nagrody, wyróżnienia, patenty w ostatnich 5 latach)

Złoty Krzyż Zasługi
Postanowienie Prezydenta Rzeczpospolitej Polskiej z dnia 21.01.2021 r. Legitymacja nr 15-2021-13

Medal im. prof. Mieczysława Pożaryskiego w uznaniu wybitnych osiągnięć naukowo-dydaktycznych w elektronice oraz w podziękowaniu za wieloletnią współpracę ze Stowarzyszeniem Elektryków Polskich. Decyzja Zarządu Głównego SEP - Prezes SEP. 11 grudnia 2020 rok.

Złoty medal „Siły Zbrojne w Służbie Ojczyzny"
Decyzją nr 2202/KADR Ministra Obrony Narodowej z dnia 12.07.2022 r. w sprawie nadania Złotego Medalu „Siły Zbrojne w Służbie Ojczyzny" Legitymacja nr 2202-2022-14

Dyplom w uznaniu zaangażowania i wkładu pracy w realizację zadań związanych z promocją Wojskowej Akademii Technicznej w 2022 roku. Prorektor ds. rozwoju WAT płk dr hab. inż. Jacek Świderski, prof. WAT 11 stycznia 2023 r.

Dyplom – Nagroda Rektorska w kategorii osiągnięcie naukowe dla zespołu za opracowanie i przetestowanie innowacyjnego systemu o nazwie IDvictim który zapewnia efektywną i szybką identyfikację ofiar katastrof lub ataków terrorystycznych poprzez usprawnienie działań służb na wszystkich etapach postępowania ze zwłokami i szczątkami ludzkimi. Rektor WAT gen. bryg. prof. dr hab. inż. Przemysław WACHULAK. Warszawa 2023 rok.

Medal za duże zaangażowanie w prace na rzecz Wydziału Cybernetyki WAT.
Warszawa 1.10.2023 r. Nadany przez Dziekana WCY WAT dr hab. .inż. Zbigniewa TARAPATĘ.

Złoty medal „Za Zasługi dla Wojskowej Akademii Technicznej" Decyzja Rektora-Komendanta nr 274/RKR/2023 z dnia 20.10.2023 r.

Dyplom – Nagroda Rektorska w kategorii osiągnięcie naukowe dla zespołu za realizację projektu SOFTAWARE DEFINED TACTICAL & THEATRE NETWORK, wynikiem którego jest opracowanie i

przetestowanie w składzie międzynarodowego konsorcjum, bezpiecznego systemu łączności operującego w działaniach taktycznych w Sieciach Definiowanych Programowo. Rektor WAT gen. bryg. prof. dr hab. inż. Przemysław WACHULAK. Warszawa 2024 rok.

Dyplom Uznania Rady Programowej Forum Teleinformatyki dla płk dr hab. Inż. Zbigniewa Piotrowskiego z Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego za opiekę naukową nad praca konkursową pt. „Bezzałogowy System Powietrzny Rozpoznania i Ataku sieci Radiowych HackBee" Autorzy pracy: Pan Rafał Szczepanik, Pana Tomasz Walczyna. Praca ta uzyskała wyróżnienie w XVI edycji Ogólnopolskiego Międzyuczelnianego konkursu Młodych Mistrzów. Tematyka Konkursu: Ekonomiczne aspekty informatyzacji państwa, Cyfrowa Modernizacja Polski. 28 sierpnia 2024 rok

Dyplom w uznaniu zaangażowania i wkładu pracy w realizację zadań związanych z promocją Wojskowej Akademii Technicznej w 2025 roku – Prorektor ds. rozwoju WAT 5.09.2025 rok

Doświadczenie w pracy promotorskiej i recenzenckiej

(liczba wypromowanych doktorów, liczba recenzji: doktorantów, w postępowaniach habilitacyjnych, opinie w postępowaniach profesorskich, w ostatnich 5 latach)

2020 - **Jarosław Wojtuń** „Efektywne metody skrytej synchronizacji akustycznych kanałów steganograficznych". Promotor: Zbigniew Piotrowski
2019 - **Piotr Lenarczyk** „Skryta transmisja danych w systemie cyfrowej telewizji naziemnej DVB-T" promotor: Zbigniew Piotrowski
2019 – **Krzysztof Sawicki** promotor: Zbigniew Piotrowski

2025 rok recenzent w przewodzie doktorskim: dr inż. Kamil Faber (AGH)
2024 rok recenzent w przewodzie doktorskim: dr inż. Jan Derkacz (AGH)
2023 rok recenzent w przewodzie doktorskim: dr inż. Michał Kucab (AGH)
2022 rok recenzent w przewodzie doktorskim: dr inż. Grzegorz Siewruk (PW)
2022 rok recenzent w przewodzie doktorskim: dr inż. Łukasz Rybak (PŁ)
ponad 50 recenzji w czasopismach z listy JCR za lata 2021-2025

Dane kontaktowe

Miejsce pracy: nr budynku/nr pokoju: nr 47 pok.138

Tel.: 261-83-77-33

Email: zbigniew.piotrowski@wat.edu.pl

Uwaga: nie więcej niż 4 strony, w razie pytań i uwag proszę o kontakt: piotr.zalewski@wat.edu.pl tel. 603 889 905

Wizytówka naukowa pracownika WAT

Tytuł/stopień naukowy Imię i Nazwisko, Nr ORCID

Dr hab. inż. Zbigniew Tarapata, 0000-0001-8143-7869

Stanowisko, funkcja kierownicza

Profesor WAT, dziekan Wydziału Cybernetyki

Reprezentowana dyscyplina naukowa (dyscypliny naukowe %)

Informatyka techniczna i telekomunikacja (100%)

Obszar zainteresowań naukowych

oparte na wiedzy informatyczne systemy wspomagania decyzji; optymalizacja grafowo-sieciowa oraz modele i metody eksploracji grafów; analiza, modelowanie i prognozowanie zagrożeń (w tym cybernetycznych); modelowanie, optymalizacja i symulacja działań bojowych; analiza efektywności algorytmów; optymalizacja transportu

Działalność organizacyjna
(udział w pracach różnych gremiów, pełnione funkcje, w ostatnich 5 latach)

1. dziekan Wydziału Cybernetyki WAT
2. przewodniczący rady dyscypliny naukowej informatyka techniczna i telekomunikacja WAT

Działalność badawcza
(udział w programach, projektach, grantach, sposób finansowania, w ostatnich 5 latach)

1. w latach 2018-2020 udział w projekcie POIR.01.01.01-00-1146/17, pt.: "Opracowanie i badanie własności nowych metod i technik optymalizacji procesów dystrybucji towarów i usług" (Kierownik Prac Badawczych);
2. w latach 2018-2020 w projekcie NCBiR pt. "Opracowanie bazy danych oraz narzędzia do semantycznego poszukiwania informacji i zarządzania wiedzą w obszarze zaginięć i poszukiwania osób" (wykonawca);
3. w roku 2020 w projekcie pt.” Analiza algorytmów (modeli i metod) eksploracji danych, w szczególności z obszaru uczenia maszynowego, na potrzeby rozpoznania zachowań ludzi na podstawie cech pozyskanych z przetwarzania obrazu oraz analiza metod i systemów pomiarowych wykorzystywanych w wielosensorycznych urządzeniach obserwacyjnych, na potrzeby rozpoznania zachowań ludzi” (podwykonawca w ramach programu NCBiR dla małych i średnich przedsiębiorstw);
4. w latach 2020-2021 w projekcie pt. "Opracowanie metodyki oceny ryzyka oraz analizy usług i procesów realizowanych przez operatorów Infrastruktury Krytycznej (IK)" Nr postępowania 2/PU/RCB/2020, realizowany dla RCB ze środków finansowych Funduszu Bezpieczeństwa Wewnętrznego i podpisanym Porozumieniem Finansowym nr 88/PL/2020/FBW z dn. 23.06.2020.
5. w latach 2024-2025 w projekcie niejawnym na zlecenie Polskiej Grupy Zbrojeniowej w ramach programu Wisła-Narew (wykonawca).
6. w latach 2024-2028 udział w projekcie finansowanym przez Europejską Agencję Obrony (EDF) nr 101168202 EDF-2023-DA-CYBER-DAAI pt. Artificial Intelligence Deployable Agent (AIDA), (wykonawca).

Działalność publikacyjna
(liczba publikacji, Index Hirscha, informacja z bazy Web of Science, Scopus, najważniejsze publikacje w ostatnich 5 latach)

a) Liczba publikacji w ostatnich 5 latach: 16
b) Indeks Hirscha wszystkich publikacji według:
    a. Google Scholar: 15
    b. Scopus: 7
    c. Web of Science: 5

Najważniejsze publikacje z ostatnich 5 lat:

a) Tarapata Z., Nowicki T., Antkiewicz R., Dudziński J., Janik K.: Data-Driven Machine Learning System for Optimization of Processes Supporting the Distribution of Goods and Services – a case study, Procedia Manufacturing 44C pp. 60-67 (2020).
b) Skrzypecki S., Tarapata Z., Pierzchała D.: Combined PSO Methods for UAVs Swarm Modelling and Simulation, J. Mazal et al. (Eds.): MESAS 2019, LNCS 11995, pp. 1–15, (2020);
c) Antkiewicz R., Najgebauer A., Pierzchała D., Tarapata Z.: Complex activities analyzer as a software tool for modelling and simulation in crisis management, 35th Annual European Simulation and Modelling Conference 2021, ESM 2021, Pages 246 – 253, Rome 27-29 October (2021).
d) Kulas W., Tarapata Z., Simulated Annealing Algorithm for Solving Modified VRPTW Problem in Time-Dependent Networks: A Case Study, Proceedings of the 37th International Business Information Management Association Conference (IBIMA), 30-31 May 2021, Cordoba, Spain, ISBN: 978-0-9998551-6-4, ISSN: 2767-9640, pp.7351-7360.
e) Tarapata, Z., Kulas, W., Antkiewicz, R., Machine learning algorithms for the problem of optimizing the distribution of parcels in time-dependent networks: the case study. Archives of Transport, 61(1), 133-147. DOI: https://doi.org/10.5604/01.3001.0015.8269, (2022).
f) Muszynski, S.; Tarapata, Z. Methods of Automated Music Comparison Based on Multi-Objective Metrics of Network Similarity. Appl. Sci. 13, 3567, https://doi.org/10.3390/app13063567, (2023).
g) Tarapata Z.: Wykorzystanie metod eksploracji grafów w cyberbezpieczeństwie, w: Szafrański B. (red.): Cyberbezpieczeństwo. Redefinicja zagrożeń, 978-83-7938-403-7, Wojskowa Akademia Techniczna, Warszawa, str. 315-342 (2023)
h) Tarapata Z., Romańczuk J.: Metody grafowego uczenia maszynowego w cyberbezpieczeństwie, w: Szafrański B. (red.): Cyberbezpieczeństwo vs. Sztuczna Inteligencja. Informatyka - prawo – zarządzanie, Wojskowa Akademia Techniczna, Warszawa, 223-252 (2024).
i) Tarapata Z., Romańczuk J.: Metody wykrywania złośliwego oprogramowania bazujące na grafowym uczeniu maszynowym, w: Szafrański B. (red.): Cyberbezpieczeństwo vs. Konfrontacja informacyjna. Informatyka - prawo – zarządzanie, Wojskowa Akademia Techniczna, Warszawa, 223-245, (2025).

Działalność dydaktyczna
(prowadzone przedmioty, w tym w SDR, średnia liczba godzin zajęć, w ostatnich 5 latach)

1. Średnia liczby godzin zajęć dydaktycznych na rok za ostatnie pięć lat: 198
2. Prowadzone przedmioty w Szkole Doktorskiej WAT:
    a. Analiza algorytmów III (20 godz./rok)

b. Teoria grafów i sieci III (20 godz./rok)

3. Prowadzone przedmioty na studiach wyższych i podyplomowych w WAT:
    a. Teoria grafów i sieci (74 godz./rok)
    b. Modelowanie matematyczne (10 godz./rok)
    c. Techniki algorytmiczne (38 godz./rok)
    d. Obliczenia równoległe i rozproszone (12 godz./rok)
    e. Decyzje menadżerskie (MBA) (24 godz./rok)

Osiągnięcia
(nagrody, wyróżnienia, patenty w ostatnich 5 latach)

1. Przyznane krzyże, medale, odznaczenia:
    a. Złoty Krzyż Zasługi, XI.2023
    b. Złoty medal „Siły Zbroje w Służbie Ojczyzny”, 2021
2. Wpisanie na Listę'100 2024 za wyjątkowy wkład w budowanie nowoczesnej, cyfrowej Polski, wyróżnienie przyznane przez Szerokie Porozumienie na Rzecz Umiejętności Cyfrowych w Polsce, wręczone przez Ministra Cyfryzacji.

Doświadczenie w pracy promotorskiej i recenzenckiej
(liczba wypromowanych doktorów, liczba recenzji: doktorantów, w postępowaniach habilitacyjnych, opinie w postępowaniach profesorskich, w ostatnich 5 latach)

1. Liczba wypromowanych doktorów: 1
2. Liczba recenzji doktoratów: 2
3. Liczba opinii w postępowaniach habilitacyjnych: 1

Dane kontaktowe

Miejsce pracy: Wydział Cybernetyki, nr budynku/nr pokoju: budynek 100, pokój 271

Tel.: 261 838 798

Email: zbigniew.tarapata@wat.edu.pl

Uwaga: nie więcej niż 4 strony, w razie pytań i uwag proszę o kontakt: piotr.zalewski@wat.edu.pl tel. 603 889 905

Wizytówka naukowa pracownika WAT

Tytuł/stopień naukowy Imię i Nazwisko, Nr ORCID

Profesor nt. , dr hab. inż. ANDRZEJ WALCZAK , 0000 0002 5038 7149

Stanowisko, funkcja kierownicza

Kierownik Z-du Inżynierii Oprogramowania

Reprezentowana dyscyplina naukowa (dyscypliny naukowe %)

Informatyka techniczna i telekomunikacja

Obszar zainteresowań naukowych

symulacje komputerowe systemów optoelektronicznych, sztuczna inteligencja w systemach medycznych, informatyka kwantowa

Działalność organizacyjna
(udział w pracach różnych gremiów, pełnione funkcje, w ostatnich 5 latach)

do 2024-07-01 | member (Scientific Council)

Membership w Bio-Algorithms and Med-Systems, Kraków, UJ

Członek Rady Naukowej kilku konferencji krajowych i międzynarodowych

Do 2025 członek Rady Dyscypliny Informatyka Techniczna i Telekomunikacja

Działalność badawcza
(udział w programach, projektach, grantach, sposób finansowania, w ostatnich 5 latach)

Projekt Amulet – finansowanie NCBiR, kierownik projektu
Hub Kwantowy w WAT dla RON – finansowanie MON, kierownik projektu

Działalność publikacyjna
(liczba publikacji, Index Hirscha, informacja z bazy Web of Science, Scopus, najważniejsze publikacje w ostatnich 5 latach)

Ok. 200, wg. Google Scholar: 266 cytowań z 90 zamieszczonych tam artykułów bez autocytowań i cytowań krzyżowych, h=8,

Advances in Intelligent Systems and Computing

2020 | Book

DOI: 10.1007/978-3-030-20145-6_20

EID: 2-s2.0-85067404026

Contributors: Waszkowski, R.; Nowicki, T.; Walczak, A.

Tytuł: Monitoring personnel presence and displacement in production facilities using RFID technologies

JMIR mHealth and uHealth

2021-05-05 | Journal article

DOI: 10.2196/25937

Contributors: Pawel Krzesinski; Aleksander Sobotnicki; Adam Gacek; Janusz Siebert; Andrzej Walczak; Piotr Murawski; Grzegorz Gielerak

Tytuł: Noninvasive bioimpedance methods from the viewpoint of remote monitoring in heart failure

Teleopieka ambulatoryjna w niewydolności serca

2021 | Book chapter | *Author*

SOURCE-WORK-ID: 6152e8122467f02da4b2351a

Contributors: Andrzej Walczak; Paweł Krzesiński; Piotr Bączyk

Tytuł: Systemy telemedyczne jako systemy teleinformatyczne

ESC heart failure

2021 | Journal article | *Author*

DOI: 10.1002/ehf2.13330

SOURCE-WORK-ID: 611fad512467f06581c71242

Contributors: Ewa Anita Jankowska; Grzegorz Gielerak; Adam Stańczyk; Katarzyna Piotrowicz; Paweł Krzesiński; Agata Galas; Janusz Siebert; Waldemar Banasiak; Piotr Murawski; Piotr Gutknecht et al.

Tytuł: Rationale and design of the AMULET study: a new model of the telemedical care in patients with the heart failure

37th International Business Information Management Association Conference

2021 | Conference paper | *Author*

SOURCE-WORK-ID: 60f019ee2467f02be3f71b22

Contributors: Paweł Moszczyński; Andrzej Walczak; Paweł Krzesiński

Tytuł: Prediction of the cardiological parameters evolution with the Markov Model

ESC heart failure

2021 | Journal article | *Author*

DOI: 10.1002/ehf2.13207

SOURCE-WORK-ID: 606323f92467f05a448a2376

Contributors: Ewa Anita Jankowska; Paweł Chrom; Piotr Gutknecht; Paweł Siwołowski; Adam Stańczyk; Katarzyna Piotrowicz; Agata Galas; Piotr Murawski; Janusz Siebert; Paweł Krzesiński et al.

Tytuł: Nurse-led ambulatory care supported by non-invasive haemodynamic assessment after acute heart failure decompensation

Teleopieka ambulatoryjna w niewydolności serca

2021 | Book chapter | *Author*

SOURCE-WORK-ID: 6152e67e2467f02da4b1e9db

Contributors: Paweł Moszczyński; Andrzej Walczak

Tytuł: Moduł predykcji na platformie Amulet

Applied Sciences

2021 | Journal article | *Author*

DOI: 10.3390/app112311412

SOURCE-WORK-ID: 61af22032467f044f4d07259

Contributors: Paweł Moszczyński; Andrzej Walczak; Paweł Krzesiński

Tytuł: Evolution of hemodynamic parameters simulated by means of diffusion models

EUROPEAN JOURNAL OF HEART FAILURE

2021 | Journal article | *Author*

DOI: 10.1002/ejhf.2358

SOURCE-WORK-ID: 61bb30c42467f079a079ee78

Contributors: Agata Galas; Piotr Gutknecht; Paweł Siwołowski; Dominika Szalewska; Paweł Krzesiński; Piotr Murawski; Paweł Chrom; Piotr Ponikowski; Waldemar Banasiak; Grzegorz Gielerak et al.

Tytuł: Effects of an outpatient intervention comprising nurse-led non-invasive assessment, telemedicine support and remote cardiologists' decisions in patient with heart failure

37th International Business Information Management Association Conference

2021 | Conference paper | *Author*

SOURCE-WORK-ID:

60debe852467f0798ef15181

Contributors: Andrzej Walczak; Piotr Bączyk

Tytuł: Autonomic control of measurement data integrity in telemedicine systems

Entropy

2022-12-06 | Journal article

DOI: 10.3390/e24121780

Contributors: Andrzej Augustyn Walczak
Tytuł : Heart failure evolution model based on anomalous diffusion theory

Expert Systems with Applications

2024-08-01 | Journal article | *Investigation*

Contributors: Andrzej Walczak; Michał Gałusza

Tytuł: Graph-based document level relationship extraction for risk analysis: A transitive and dialog coherence approach

2025 | Book chapter

DOI: 10.1007/978-3-031-76440-0_16

Contributors: Michał Gałusza; Andrzej Walczak

Tytuł: Document level relationship extraction using network representation of text

Działalność dydaktyczna

(prowadzone przedmioty, w tym w SDR, średnia liczba godzin zajęć, w ostatnich 5 latach)

Programowanie w językach funkcyjnych, Programowanie obiektowe, Fizyczne Podstawy Informatyki Kwantowej, Sieci neuronowe i logika rozmyta, Systemy zobrazowania i modelowanie geometryczne, Metody analizy i syntezy sygnałów, Analiza informacji wizualnej, Analiza danych w kardiologii, Informatyka kwantowa, Standardy wytwarzania systemów medycznych, Wybrane Elementy Obliczeń Kwantowych
Średnia liczba godzin zajęć semestralnie ok.130 godzin tj. ok. 260 godzin w roku

Osiągnięcia

(nagrody, wyróżnienia, patenty w ostatnich 5 latach)

Dwa patenty ETO (tzn. europejskie), **dwukrotnie** nagroda JM Rektora WAT za przygotowanie i uruchomienie międzywydziałowego kierunku studiów Biocybernetyka i Inżynieria Biomedyczna oraz przygotowanie i uruchomienie specjalności Informatyka Kwantowa na kierunku Informatyka

Doświadczenie w pracy promotorskiej i recenzenckiej

(liczba wypromowanych doktorów, liczba recenzji: doktorantów, w postępowaniach habilitacyjnych, opinie w postępowaniach profesorskich, w ostatnich 5 latach)

wypromowanych doktoratów 2, liczba recenzji doktoratów 3, liczba recenzji w postępowaniu habilitacyjnym 3, opinie profesorskie 2

Dane kontaktowe

Miejsce pracy: nr budynku/nr pokoju:

Tel.: 608 354 373

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Professor PhD, D.Sc., Eng. Leszek R. Jaroszewicz, corresponding member of PAS,
ORCID No 0000-0001-8838-5846

Position, management function

Appointed research and teaching professor

Scientific discipline represented (scientific disciplines %)

Materials science

Area of scientific interest

Fibre optic photonics, especially in the field of sensor technology, where the key area of interest is the use of the Sagnac-von Laue effect through the construction and application of a globally innovative fibre optic gyroscope-based rotational seismograph and the implementation of FOG in small-size INS systems.

Organizational activities

(participation in the work of various bodies, functions performed, in the last 5 years)

Member: Council of Trustees of the IV Faculty of the Polish Academy of Sciences (PAS) (2020-), Science Dissemination Department Committee of the PAS (2023-2026), Electronics and Telecommunications Committee of the PAS (2019-), Materials Science and Metallurgy Committee of the Polish Academy of Sciences (2019-), Programme Council of the Laser Metal Technology Centre of the Czestochowa University of Technology and the PAS (2021-), Competition Committee for the selection of the director of the Institute of Geography and Spatial Organization of the PAS (2021/2022), team for the evaluation of the Institute of Metallurgy and Materials Science of the PAS for the years 2017-2021, Council of the Materials Science Discipline at the Military University of Technology (2020-), Scientific Council of the Institute of Geophysics PAS (2023-2026), Scientific Council of the Strata Mechanics Research Institute PAS (2023-2026), Scientific Council of Space Research Centre PAS (2023-2026), International Honorary Committee of International Conference on Optical Fibre Sensor - OFS (2015–), Steering Committee of EWOFS (2015-), Chairman of the PAS team for the evaluation of the Institute of Environmental Engineering PAS for the years 2022-2024, Vice-Chairman of the Polish Photonics Society (2015-), editor-in-chief of the JCR-listed journal Opto-Electronics Review (2015-).

Research activities

(participation in programs, projects, grants, method of financing, in the last 5 years)

Participation in: 3 EU COST projects as a member of the Management Committee, 10 university projects, including 8 as project manager, 36 competitive projects, including 26 as project manager and 10 as principal investigator; 6 projects as project manager over the last 5 years:

- 2016-2021: OPI – POIR.04.02.00-14-A003/16 „EPOS – System Obserwacji Płyty Europejskiej" – task manager, European Structural Funds
- 2018-2022: GBMON/13-995/2018/WAT „Fundamentals of innovative dual-use materials and technologies", - project manager, Ministry of Defence Funds
- 2021-2023: NCBiR - POIR.01.01.01-00-1553/20-00 „FOSREM – from the sky through the earth to underground applications" – R&D manager, European Structural Funds
- 2024-2027: PARP – FENG.01.01-IP.02-1714/23 „FOM-MEM: Fiber-Optic Matrix for Mechanical Events Mapping" - R&D manager, European Structural Funds
- 2025-2027: COP Łódź - FELD-01.02-IP.02-0019/24 „FOG for selected applications in INS" – R&D manager, European Structural Funds
- 2025-2026: 4000146945/24/NL/MGU "Ultra-High Performance Gyroscope for Future X-ray Interferometer Missions" – principal investigator, ESA Fonds

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Bibliography as of 3 October 2025: h-index=22, citations – 2,175 (Web of Science); h-index=24, citations – 2,572 (Scopus); h-index=27, citations - 2,896 (Google Scholar); continuous presence since 2019 on the World's TOP 2% Scientists list (Stanford University); a total of 448 publications, including:

- 164 (23 for 2021-2025) publications in JCR journals, the five most important ones:
  - ❖ F. Bernauer, K. Behnen, J. Wassermann, S. Egdorf, H. Igel, S. Donner, K. Stammler, M. Hoffmann, P. Edme, D. Sollberger, C. Schmelzbach, J. Robertsson, P. Paitz, J. Igel, K. Smolinski, A. Fichtner , Y. Rossi, G. Izgi, D. Vollmer, E. P.S. Eibl, S. Buske, C. Veress, F. Guattari, T. Laudat, L. Mattio, O. Sèbe , S. Olivier, C. Lallemand, B. Brunner, A. T. Kurzych, M. Dudek, L. R. Jaroszewicz, J. K. Kowalski, P. Bonkowski, P. Bobra, Z. Zembaty, J. Vackár, J. Málek, J. Brokesova "Rotation, Strain and Translation Sensors Performance Tests with Active Seismic Sources", *Sensors*, **21**, (2021), 264, https://doi.org/10.3390/s21010264, IF=3.275
  - ❖ T. Kurzych, L. R. Jaroszewicz, M. Dudek, B. Sakowicz, J. K. Kowalski „Towards uniformity of rotational events recording – initial data from common test engaging more than 40 sensors including a wide number of fiber-optic rotational seismometers," *Opto-Electron. Rev.,* **29**(1), (2021), 39-44, https://doi.org/10.24425/opelre.2021.135827, IF=2,489
  - ❖ E. Nabadda, N. Bennis, M. Czerwinski, A. Walewska, L. R. Jaroszewicz, M.d.Mar Sanchez-Lopez,I. Moreno, "Ferroelectric liquid–crystal modulator with large switching rotation angle for polarization–independent binary phase modulation", *Opt. Lasers Eng*. **159** (2022), 107204, https://doi.org/10.1016/j.optlaseng.2022.107204 , IF=5,666
  - ❖ A.T. Kurzych, L.R. Jaroszewicz, J.K. Kowalski „Development of Three-Axis Fibre-Optic Seismograph for Di-rect and Autonomous Monitoring of Rotational Events with Perspective of Historical Review", *Sensors*, **22**, (2022), 8902, https://doi.org/10.3390/s22228902, IF=3.847
  - ❖ A.T. Kurzych, L.R. Jaroszewicz, M. Dudek "Rotational motion investigation in seismology – remote sensing by an optical fiber seismograph," *Adv. Opt. Technol*., **13**, 1494705 (2024), https://doi.org/10.3389/aot.2024.1494705, IF=2.300
- 13 (1 for 2021-2025) chapters in English-language monographs,
- 26 English-language peer-reviewed publications outside the JCR database,
- 179 (5 for 2021-2025) English-language post-conference publications,
- 23 peer-reviewed articles in Polish,
- 45 conference articles in Polish,
- 181 unpublished studies and conference presentations (invited -33, plenary and poster).

Education activities

(modules, average number of hours of classes, in the last 5 years)

'Physics 1' and 'Physics 2' – for the 1st and 2nd year of the first-cycle full-time studies in materials science and chemistry (joint stream), 'Non-telecommunications applications of optical fibres' – for full-time second-cycle studies in materials science – elective subject, 'Non-telecommunications applications of optical fibres: components, techniques, sensors' – for SDR, materials science discipline – elective course, "Methodology of conducting scientific research" – for SDR. Average number of classes over the last 5 years – 152 hours, which is almost 200% of the teaching norm.

Achievements

(awards, distinctions, patents in the last 5 years)

Fellow of SPIE (2003), Gold Cross of Merit (2004), entry in the 'Golden Book of Achievements of the Military University of Technology' (2014), Ministry of Science and Higher Education Award for lifetime achievement (2015), Janusz Groszkowski SEP Medal (2017), 12 awards at international innovation exhibitions for solutions related to fibre optic sensors (IENA'94 – bronze medal for Double-Chanel Wave-Guide Gyroscope, IENA'94 – gold medal for Light Guide Protection, EUREKA'2003 – bronze medal for Fibre Interferometer for OCT, INNOWACJE'2005 – gold medal for the FORS-II - fibre optic rotational seismometer, EUREKA'2005 – gold medal for FORS-II, EUREKA'2009 – gold medal with distinction for AFORS, SIIF'2009 – gold medal, special award from the Korean Invention Promotion Association, Diploma from Bauman Moscow State Technical University for AFORS, 49th International Exhibition of Innovation Geneva'2024 – silver medal and Thailand Award for the Best Invention and Innovation for FOSREM-3D).

Patent activity: 14 (1 for 2021-2025) patents, including 1 EPO, 21 (2 for 2021-2025) patent applications.

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Promoted doctors – 13 (2000 with distinction, 2000 with distinction, 2004 with distinction, 2005, 2014 with distinction, 2014, 2015 with distinction, 2017 with distinction, 2018, 2020 with distinction, 2021, 2023, 2023 with distinction). Number of reviews: doctoral students - 26 (8 in the last 5 years), in habilitation proceedings – 10 (1 in the last 5 years), opinions in professorial proceedings - 15 (2 in the last 5 years).

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Prof. dr hab. Małgorzata Norek, https://orcid.org/0000-0002-0460-486X

Position, management function

Full Professor

Scientific discipline represented (scientific disciplines %)

Materials engineering (100%)

Area of scientific interest

Prof. Norek's research activities focus on studies of porous anodic aluminum oxide (AAO) and its applications in materials engineering and photonics. Her work involves developing new parameters for aluminum anodization processes using unconventional electrolytes (including malic, citric, and glycolic acid solutions) to obtain AAO with pore spacing in the range of visible light wavelengths and with enhanced pore ordering.

She conducts research on the stability of high-voltage anodization processes and on the influence of organic additives (such as ethanol and ethylene glycol) on the morphology and structural ordering of AAO. Her interests also include the mechanisms of nanopore self-organization and theoretical models describing their formation, such as the electroconvection and plastic flow models of Al_2O_3.

An important part of her work concerns the engineering of photonic materials based on AAO exhibiting photonic stopbands (PSB) in the near- (NIR) and mid-infrared (MIR) ranges. These materials are synthesized via pulsed anodization, and their optical properties are optimized using numerical simulations (e.g., the Transfer Matrix Method). Within her research group at the Institute of Optoelectronics, Military University of Technology (WAT), photonic Bragg mirrors and interference filters with unique NIR–MIR properties are being developed.

The results of these studies have strong application potential in environmental protection, medical diagnostics, and food quality control, owing to the possibility of detecting characteristic vibrational bands of molecules (e.g., CO_2, CH_4) in the MIR range corresponding to the so-called atmospheric windows.

In parallel, Prof. Norek conducts research on the use of AAO as a template for fabricating regular semiconductor nanostructures such as ZnO, SnO_2, and other metal oxide nanotubes and nanowires. The aim of this work is to improve the optical properties of materials through controlled surface modification of nanostructures using metal nanoparticles (Ag, Au, Al) generating localized surface plasmon resonance (LSPR) and wide-bandgap oxide coatings that facilitate efficient charge and energy transfer. The resulting materials can be applied in efficient, low-cost light-emitting diodes (LEDs) and photocatalytic systems.

Organizational activities

(participation in the work of various bodies, functions performed, in the last 5 years)

- Chair of the Disciplinary Committee for PhD Students at WAT
- Member of the Scientific Discipline Council (RDN) “Materials Engineering” at WAT
- Chair of the Personnel Committee within the RDN “Materials Engineering” at WAT
- Member of the Management Committee (MC) and Grant Awarding Coordinator of COST Action CA20126 (European Cooperation in Science and Technology) entitled “Network on Porous Semiconductors and Oxides”; https://netpore.eu/NTP/cg.php

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Grant NCN OPUS 19, project no. 2020/37/B/ST5/01674: „Study of synergistic effects between collective and individual amplifying modes in one optical system - towards efficient ZnO-based UV light emitters” **–** *principal investigator*

Project description: *https://projekty.ncn.gov.pl/opisy/484166-en.pdf*

2. Grant NCN OPUS 18, project no. 2020/37/B/ST5/01025: „Novel porous photonic materials with tunable stop band in VIS-MIR spectral region” **–** *principal investigator*

Project description: *https://projekty.ncn.gov.pl/opisy/460622-en.pdf*

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

91 publications from the MNiSW list, Hirscha Index = 29 (Google Scholar)/26 (Scopus)

Selected publications:

1) D. Siemiaszko, Małgorzata Norek, „The mean angle of displacement (MAD) as a simple parameter for determining the degree of ordering of hexagonal arrays”, *Acta Materialia* 296, **2025**, 121300;

2) Aleksandra M Figat, Malwina Liszewska, Bogusław Budner, Bartosz Bartosewicz, Małgorzata Norek, Bartłomiej J Jankiewicz, „Monolayers of Amino Acid-Synthesized Gold Nanoparticles as SERS Substrates for Trace Chemical Sensing”, *Langmuir*, 41, **2025**, 19706-19719.

3) Ajay K Potbhare, Rohit S. Madankar, Shubham S. Tripathy, Aniruddha Mondal, Aniket Kahate, Pavan Bhilkar, Małgorzata Norek, Martin Federico Desimone and Ratiram Gomaji Chaudhary, „Sustainable and Economical Approach for Effective Adsorption of Antibiotics and Heavy Metal Ions using Neolamarckia cadamba-mediated MgO-rGO Nanocomposites”, *Nanoscale*, **2025**, https://doi.org/10.1039/D5NR02246K.

4) Ewelina Białek, Maksymilian Włodarski, Małgorzata Norek, „Designing porous photonic crystals for MIR spectral region - a deeper insight into the anodic alumina

layer thickness versus charge density relation", *Nanotechnology*, 34, **2023**, 125603.

5) Ewelina Białek, Maksymilian Włodarski, Małgorzata Norek, „Influence of Anodization Mode and Temperature on the Optical Properties of Photonic Crystals Based on Porous Anodic Alumina", *Journal of the Electrochemical Society*, 170, **2023**, 123507.

6) M. Włodarski, M.P. Nowak, M. Putkonen, P. Nyga, M. Norek, "Surface modification of ZnO nanotubes by Ag and Au coatings of variable thickness: systematic analysis of the factors leading to UV light emission enhancement", *ACS Omega* 9(1), **2024**, 1670-1682.

7) S. Gierałtowska, W. Zaleszczyk, M. Putkonen, D. Zasada, K.P. Korona, ***M. Norek***, "Regularly arranged ZnO/TiO_2, HfO_2, and ZrO_2 core/shell hybrid nanostructures-towards selection of the optimal shell material for efficient ZnO-based UV light emitters", *Ceramics International* 49 (19), **2023**, 31679-31690.

8) A.M. Figat, B. Bartosewicz, M. Liszewska, B. Budner, M. Norek, B.J. Jankiewicz, α-Amino Acids as Reducing and Capping Agents in Gold Nanoparticles Synthesis Using the Turkevich Method, *Langmuir* 39(25), **2023**, pp. 8646-8657.

9) G. Szwachta, B. Januszewska, M. Włodarski, M. Norek, From gradient-index to step-index filters: A switch between the two types of photonic crystals induced by the amplitude and period of sinusoidal function applied during high-temperature anodisation of aluminium, *Applied Surface Science* 607, **2023**, 155031.

10) M. Norek, Self-ordered porous anodic alumina with large pore intervals: review on experimental and theoretical research, *Journal of the Electrochemical Society* 169 (12), **2022**, 123503.

11) G. Szwachta, E. Białek, M. Włodarski, M. Norek, Structural stability and optical properties of 1D photonic crystals based on porous anodic alumina after annealing at different temperatures, *Nanotechnology* 33 (45), **2022**, 455707.

12) E. Białek, G. Szwachta, M. Kaliszewski, M. Norek, Charge density-versus time-controlled pulse anodization in the production of PAA-based DBRs for MIR spectral region, *Energies* 14 (16), **2021**, 5149.

Education activities

(modules, average number of hours of classes, in the last 5 years)

1) Principles of Selecting Engineering Materials – lectures (18 h) + exercises (22 h) in Polish,

2) English for Material Engineers – seminar in English (32 h),

3) Nanoporous Anodic Aluminum Oxide: Synthesis, Design, and Applications – lecture in Polish SDR (20 h),

4) Electrochemical Synthesis of Anti-Reflective, Superhydrophobic Coatings and

Photonic Crystals – lecture in Polish SDR (20 h),

4) Methods for Enhancing Light Emission in Broad-Band Semiconductor Nanostructures – lecture in Polish SDR (20 h),

5) Methods for Amplifying Light Emission from Broad-Band Semiconductor Nanostructures – lecture in English in SDR (20 h).

Achievements
(awards, distinctions, patents in the last 5 years)

In 2024, she was listed among **World's Top 2% Scientists** in a ranking prepared by Stanford University in collaboration with Elsevier.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

PhD thesis reviews:

1. 2024 – Dipl. Chem. Monika Lelonek: "Growth of Nano Porous Alumina on Various Geometrical Structures" (supervisor: Dr. hab. Piotr Pawlik, Częstochowa University of Technology)
2. 2025 – Gohar Ijaz Dar: "Advanced Approaches to Surface-Enhanced Raman Spectroscopy: Metal-Decorated Porous Anodic Alumina as High-Performance SERS Substrates" (supervisors: Prof. Lluis F. Marsal and Prof. Elisabet Xifré, Universitat Rovira i Virgili, Tarragona, Spain)
3. 2025 – Nhu Khoa Tran: "Harnessing Light-Matter Interactions in Nanoporous Photonic Crystal Structures for Gas Sensing" (supervisor: Prof. Abel Santos, The University of Adelaide, Adelaide, Australia)

Participation in habilitation committees:

1. Reviewer in the habilitation procedure of Dr. Igor Iatsunky from Adam Mickiewicz University, Poznań
2. Secretary of the committee in the habilitation procedure of Dr. Eng. Paweł Madejczyk from Military University of Technology, Warsaw
3. Member of the committee in the habilitation procedure of Dr. Eng. Dominika Wawrzyńczyk from Wrocław University of Science and Technology

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID
Ph. D, Ds. C. Eng, Janusz PARKA, Professor, 0000-0003-2140-0452
Position, management function
Full Professor
Scientific discipline represented (scientific disciplines %)
Material Science
Area of scientific interest
Metamaterials, Liquid Crystals, Photonics, nonlinear Processes, Dynamic Holography,
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
Advisory Board of International Liquid Crystal Conference – member, , Advisory and Scientific Board of European Liquid Crystal Conference - member, Polish Photonic Society – member, Polish Liquid Crystal Society, member of Authorities,
Research activities *(participation in programs, projects, grants, method of financing, in the last 5 years)*
Techmastrateg NCBiR, project, consortium of PW, WAT, IF PAN, Tunable hyperbolic Metamaterials for new generation of photonic devices, 2017-2020, M. Era-NET, European Project: Optically addressed high-speed inorganic- organic interface for advanced optical and terahertz photonics, 2024-2027,
Publishing activities *(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)*
Index Hirsha – H = 20 (Scopus),H = 21 (Web of Science), 1. A. Pianelli, R. Kowerdziej, M. Dudek, K. Sielezin, M. Olifierczuk, and **J. Parka**, "Graphene-based hyperbolic metamaterial as a switchable reflection modulator," *Opt. Express* **25**, 670–6718 (2020). 2. V. Caligiuri, A. Pianelli, M. Miscuglio, A. Patra, N. Maccaferri, R. Caputo, **J. Parka** and A. De Luca, "Near- and mid-infrared graphene-based photonic architectures for ultrafast and low-power electro-optical Switching and ultra-high resolution imaging," *ACS Applied Nano Materials* **3**, 12218–12230 (2020). 3. M. Dudek, R. Kowerdziej, A. Pianelli, and **J. Parka**, "Graphene-based tunable microcavity," *Nature: Scientific Report* **11**, 74 (2021). 4. **A.** Pianelli, V., Caligiuri, M. Dudek, , ... R. Caputo, **J. Parka, "**Active control of dielectric singularities in indium-tin-oxides hyperbolic metamaterials**",** Scientific Reports, 12(1), 16961, (2022), 5. E. Perivolari, V.A, Fedotov, **J. Parka,** M. Kaczmarek, V. Apostolopoulos, Anomalous resonance frequency shift in liquid crystal-loaded THz metamaterials, Nanophotonics, 11(10), pp. 2341–2348, (2022**),** 6. S. Złotnik, A., Pianelli, J., Boguski,... J. Parka, J. Wróbel, Experimental Verification of Single-Type Electron Population in Indium Tin Oxide Layers, Physica Status Solidi Rapid Research Letters, 16(8), 2200170, (2022),

7. K., Sielezin, M., Dudek, U. Chodorow, **J. Parka**, “Numerical analysis of tunable edge filters based on hyperbolic metamaterials constructed from indium tin oxide and silicon oxide layers”, Opto-Electronics Review, 32(4), e152767, (2024),
8. G.E. Lio, A. Ferraro, B. Zappone, **J. Parka**, E. Schab- Balcerzak, “Unlocking Optical Coupling Tunability in Epsilon-Near-Zero Metamaterials Through Liquid Crystal Nanocavities”, Advanced Optical Materials, 12(13), 2302483, (2024).

General Physics (F1, F2), lectures, exercises, ok. 150 hours/per year, Introduction to Plasmonic and Metamaterials, (PLAZ), 40 hours per year, Doctoral School and Material Science II course, Optoelectronics Image Technology, (OTZI) 20 hours per year.

Achievements
(awards, distinctions, patents in the last 5 years)

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Promotor of 7 Ph. D. Students, 6 review of Ph. D. Thesis, 1 review of D. Sc. Thesis, 1 review of Professor Title,

Contact:

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Paweł PERKOWSKI PhD, DSc Eng, 0000-0001-7960-2191

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Material Engineering

Area of scientific interest

Condensed matter physics, optical materials, dielectric spectroscopy, liquid crystal materials, physics teaching

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Founding Member of the Polish Liquid Crystal Society

Member of the Polish Physical Society

Member of the Teaching Section of the Polish Physical Society

Head of Doctoral Studies (Faculty of New Technologies and Chemistry) 2016-2023

Member of the Organizing Committee of the OLC 2023 Conference

Member of the Organizing Committee of the CLC 2025 Conference

Coordinator (Faculty of New Technologies and Chemistry) of the first Implementation Doctorate program at the Military University of Technology (WAT) 2017-2021

Senator of the Military University of Technology (2024-2028 term)

Member of the Science Committee of the Military University of Technology Senate (2024-2028 term)

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

NAWA PPN/ BCZ Project /2019 /1/00 0 68 /U/00001 (leader) (2020-2022)
UGB Project (University Research Grant) 2021, 2022, 2023, 2024, 2025 (investigator)

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Hirsch index (Scopus): **23**
Hirsch index without self-citation (Scopus): **19**
Hirsch index (WoS): **22**

Most important publications in the last 5 years:
D. Węgłowska, M. Czerwiński, R. Dzienisiewicz, P. Perkowski, J. Szydłowska, D. Pociecha, M. Mrukiewicz, The balance between paraelectricity and ferroelectricity in non-chiral smectic homologues, (2025) Journal of Materials Chemistry C, 13 (19), pp. 9545 - 9553, DOI: 10.1039/d5tc00701a

M.Czerwiński, E.Dmochowska, J.Herman, M.Filipow, G.Biełaga, N.Lubiński, P.Perkowski, P.Kula, Chiral liquid crystal dimers with smectic phases for stabilization of anticlinic state in surface-stabilized geometry, (2024) Journal of Molecular Liquids, 412, art. yeah. 125824, DOI: 10.1016/j.molliq.2024.125824
P.Perkowski, M.Urbańska, Dielectric Modes in Antiferroelectric and Ferroelectric Liquid Crystals in a Pure Enantiomeric Version and a Racemic Mixture, (2024) Materials, 17 (13), art. yeah. 3335, DOI: 10.3390/ma17133335
M.Mrukiewicz, M.Czerwiński, N.Podoliak, D.Repcek, P.Perkowski, R.J.Mandle, D.Węgłowska, Polar nematic phases with enantiotropic ferro- and antiferroelectric behavior, (2024) Journal of Materials Chemistry C, 12 (20), pp. 7214 - 7224, DOI: 10.1039/d4tc01038h
M.Mrukiewicz, M.Cigl, P.Perkowski, J.Karcz, V.Hamplová, A.Bubnov, Dual tunability of selective reflection by light and electric field for self-organizing materials, (2024) Journal of Molecular Liquids, 400, art. yeah. 124540, DOI: 10.1016/j.molliq.2024.124540
M.Urbańska, M.Zajac, P.Perkowski, A.Deptuch, The Influence of the Molecular Structure of Compounds on Their Properties and the Occurrence of Chiral Smectic Phases, (2024) Materials, 17 (3), art. yeah. 618, DOI: 10.3390/ma17030618
M.Mrukiewicz, P.Perkowski, J.Karcz, P.Kula, Ferroelectricity in a nematic liquid crystal under a direct current electric field, (2023) Physical Chemistry Chemical Physics, 25 (18), pp. 13061 - 13071, DOI: 10.1039/d3cp00714f
M.Urbańska, O.Strzeżysz, P.Perkowski, Fluorinated esters with a very broad temperature range of the antiferroelectric phase, (2023) Liquid Crystals, 50 (13-14), pp. 2332 - 2344, DOI: 10.1080/02678292.2023.2252381
P.Zieja, M.B.Tykarska, P.Morawiak, P.Perkowski, W.Piecek, Influence of the molecular structure of compounds with terminal isothiocyanate group on the induction of the smectic A phase: Part II, (2023) Liquid Crystals, 50 (13-14), pp. 2186 - 2203, DOI: 10.1080/02678292.2023.2238655
N.Bennis, T.Jankowski, O.Strzeżysz, A.Pakua, D.C.Zografopoulos, P.Perkowski, J.M.Sanchez-Pena, J.M.López Higuera, J.F.Algorri, A high birefringence liquid crystal for lenses with large aperture, (2022) Scientific Reports, 12 (1), art. yeah. 14603, DOI: 10.1038/s41598-022-18530-z
P.Perkowski, Low-pass RC filter modified by liquid crystal exhibiting one Debye relaxation - theoretical approach, (2022) Opto-Electronics Review, 30 (3), art. yeah. e141949, DOI: 10.24425/opelre.2022.141949
P.Perkowski, The parasitic effects in high-frequency dielectric spectroscopy of liquid crystals–the review, (2021) Liquid Crystals, 48 (6), pp. 767 - 793, DOI: 10.1080/02678292.2020.1852619

Education activities
(modules, average number of hours of classes, in the last 5 years)

Teaching activities at WAT:
Subjects taught:
Physics 1 (lectures and tutorials)
Physics 2 (lectures and tutorials)
Physics 3 (lectures, tutorials, and seminars)
Theoretical Chemistry (tutorials)
Spectroscopy (laboratory)
Computer-Aided Measurement Processes (lectures and laboratory)
Physical Foundations of Analytical Techniques (tutorials)

Keysight Vee and Lab View software for control and data processing (SDR)
Quantum Mechanics in Examples (SDR)
Dielectric Spectroscopy (SDR)

Popular science activities:

Popular science articles:
P. Perkowski "Effective Mass", DELTA, 6/2020
P. Perkowski "On Chirality", DELTA, 1/2022
P. Perkowski "About Metamaterials, or Can We Measure "Negative" Permittivity?", DELTA, 6/2023
P. Perkowski "About Metamaterials, or Can We Measure "Negative" Permeability?", DELTA, 10/2023

Popular Science Lectures (Science Festival):
P. Perkowski "Interaction of Electric Fields with Matter (How a Microwave Oven Works)", FN 2019
P. Perkowski "How a Liquid Crystal Display Works, or What's Inside an LCD", FN 2025

Popular Science Lectures (YouTube):
P. Perkowski "Liquid Crystals - A Strange State of Matter"
https://www.youtube.com/watch?v=NYIS2aCRpR0&t=1858s, FN 2020
P. Perkowski "How to Solve Physics Problems?"
https://www.youtube.com/watch?v=6ipZ4tUGA2U&t=1040s, FN 2021
P. Perkowski "Radioactivity - Should We Be Afraid or Not?"
https://www.youtube.com/watch?v=y_5sBc2MVuY&t=830s, Science Cafe 1a, Wawerski Cultural Center, 2021
P. Perkowski "Why Do We Solve Physics Problems?"
https://www.youtube.com/watch?v=ylOqLY3of04&t=1874s, FN 2022
P. Perkowski "Using a Spreadsheet to Solve Simple Problems in Dynamics"
https://www.youtube.com/watch?v=l9FQ46shsIw&t=1953s, FN 2022
P. Perkowski "On Liquid Crystals"
https://www.youtube.com/watch?v=jGB6kIlbcjc&t=647s, Scientific Communicator 2022
P. Perkowski "Conditional Extrema – Mathematics and Excel"
https://www.youtube.com/watch?v=8Qm4VvrnzX4, FN 2023
P. Perkowski "The Standard Distribution – Experiment – Galton's Board"
https://www.youtube.com/watch?v=FAq3TENI-ZI&t=13s, FN 2023
P. Perkowski "Combinatorics, or... You Can Win, You Must Lose:
https://www.youtube.com/watch?v=H-6nioUzKXI&t=14s, FN 2023
P. Perkowski "Physics for the Layman - A Few Words on Falling Bodies and Mass"
https://www.youtube.com/watch?v=dY8Zm52xniY&t=466s, Scientific Communicator 2024
P. Perkowski "Apparent Forces"
https://www.youtube.com/watch?v=6dCd2CfVpys&t=5679s, FN 2024
P. Perkowski "Gravitational Slingshot"
https://www.youtube.com/watch?v=8PK1RIoZBK0&t=1995s, FN 2024
P. Perkowski "Tunnel Effect on a Desk"

https://www.youtube.com/watch?v=NHU_RTlOfZ0&list=PLEHU6P-ZzuQumI4HN6TXumy62xwV_fy8R&index=7, FN 2025
P. Perkowski "What Can We Learn About Radioactivity by Solving Problems?"
https://www.youtube.com/watch?v=9xGZHIVpmf4&list=PLEHU6P-ZzuQumI4HN6TXumy62xwV_fy8R&index=6&t=1846s, FN 2025

Over 40 hours of instruction (mostly on-line) with many secondary schools in Poland (including Ożarów Mazowiecki, Iława, Góra, Legionowo, Warsaw, Lubartów, Pisz, Jaworzno, Biała Podlaska, Poddębice, and Tomaszów Mazowiecki).

Average number of teaching hours per academic year over the last 5 years: **290** (with a teaching norm of **170**).

Achievements
(awards, distinctions, patents in the last 5 years)

The Rector of the Military University of Technology Award for Education for 2023

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Data for the last 5 years…

Number of promoted doctoral students: 0,

Number of reviews:

- doctorates: 0,

- habilitations: 0,

- opinions in professorial proceedings: 0.

Contact

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Email: pawel.perkowski@wat.edu.pl

Scientific Business Card

Title/degree Name and Surname, No ORCID

dr hab. inż. Marek Polański, Professor of MUT, ORCID: 0000-0003-0163-514X

Position, management function

Director of the Institute of Materials Science and Engineering

Scientific discipline represented (scientific disciplines %)

Materials Science and Engineering – 100%

Area of scientific interest

Hydrogen storage, additive manufacturing, mechanical synthesis

Organizational activities

(participation in the work of various bodies, functions performed, in the last 5 years)

Member of the Senate of the Military University of Technology (MUT).
Member of the Scientific Council of the Institute of Metallurgy and Materials Science of the Polish Academy of Sciences.
Member of the Steering Committee of the international Metal Hydrides Conference Series (MH) – one of the leading global conference series devoted to hydrogen storage materials.
Appointed as a governmental expert (CapTech Materials and Structures) representing the Polish Ministry of National Defence at the European Defence Agency (EDA).

Research activities

(participation in programs, projects, grants, method of financing, in the last 5 years)

In recent years, research activities have focused on two main areas: solid-state hydrogen storage and additive manufacturing of metallic materials. The studies include both the fundamental mechanisms of metal–hydrogen reactions and the development of new fabrication and modification technologies for functional materials.

Projects are being carried out with funding from the National Science Centre (NCN), the National Centre for Research and Development (NCBR), and international consortium-based programmes.

• "The influence of the thermal history on the microstructure and mechanical properties of additively manufactured materials" (2024–2028) – Principal Investigator, funding: NCN, 2,544,680 PLN.

• "The mechanisms of activation and reaction with hydrogen of solid-state hydrogen storage materials during the self-shearing reactive milling process" (2022–2026) – Principal Investigator, funding: NCN, 1,929,400 PLN.

• "Additive manufacturing of metallic auxetic structures and materials for lightweight armour (AMALIA)" (2022–2025) – project participant, consortium funding: approx. 5,000,000 EUR.

• "Thermodynamic properties of alloys from Mg–Pd and Mg–Pt systems" (2019–2022) – investigator, funding: NCN, 1,456,600 PLN.

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Author and co-author of over 100 scientific papers indexed in Scopus and Web of Science, with more than 3400 citations and an H-index of 31 (Scopus). Publications focus on hydrogen storage materials, mechanochemistry, metal hydride synthesis, and additive manufacturing. Recent work addresses high-temperature mechanochemical processes and microstructural control of metallic alloys using LENS and WAAM techniques.

1. Fadonougbo, J.O., et al., Combinatorial synthesis of solid-state hydrogen storage materials using a modified planetary ball mill. *Int. J. Hydrogen Energy*, 2025, 101, 946–958.
2. Wyrębska, I., et al., Spontaneous room temperature reaction of titanium and its alloys with hydrogen during self-shearing reactive milling. *Chem. Eng. J.*, 2024, 485, 149673.
3. Baran, A., Jensen, T.R., Polański, M., Synthesis of Mg_2FeH_6 by High-Temperature High-Pressure Reactive Planetary Ball Milling. *Adv. Eng. Mater.*, 2024.
4. Baran, A., Jensen, T.R., Polański, M., Mechanochemistry at elevated temperature and hydrogen pressure applied for the synthesis of magnesium–cobalt-based hydrogen storage materials. *J. Energy Storage*, 2024.
5. Rzeszotarska, M., et al., Feasibility Study of Metal Matrix Composite (In625–WC) Manufacturing by Laser Engineered Net Shaping (LENS®). *Arch. Metall. Mater.*, 2024, 69(4), 1675–1683.
6. Łapińska, A., et al., Flexible carbon-based fluoropolymer composites for effective EMI shielding and heat dissipation. *Polym. Compos.*, 2024, 45(5), 4319–4337.
7. Baran, A., et al., New horizon in mechanochemistry—high-temperature, high-pressure mechanical synthesis in a planetary ball mill—with magnesium hydride synthesis as an example. *Int. J. Hydrogen Energy*, 2022, 47(82), 35003–35016.
8. Pasquini, L., et al., Magnesium- and intermetallic alloys-based hydrides for energy storage: modelling, synthesis and properties. *Prog. Energy*, 2022, 4(3), 032007.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Over the past five years, teaching activities have been carried out in the field of Materials Engineering and at the Doctoral School of the Military University of Technology, including lectures, laboratory classes, and specialized seminars. The average teaching load between 2020/2021 and 2024/2025 is approximately 240 hours per academic year.

- Mechanical Synthesis
- Structural Materials
- Additive Manufacturing of Intermetallic Alloy-Based Materials (Doctoral School)
- Additive Manufacturing of Functional Materials (Doctoral School)
- Calorimetric, Thermogravimetric, and Volumetric Methods for Investigating Material Properties (Doctoral School)
- High-Energy Ball Milling and Mechanical Synthesis (Doctoral School)
- Researcher's Workshop 1 – Tools for Scientific Writing (Doctoral School)
- Researcher's Workshop 2 – Writing Scientific Papers (Doctoral School)

Teaching activities also include the design of original courses in mechanochemistry and additive manufacturing, as well as supervision of doctoral students in the field of functional and hydrogen materials.

Achievements

(awards, distinctions, patents in the last 5 years)

In the past five years, several scientific and implementation achievements have been obtained in the field of hydrogen storage technologies and additive manufacturing of metallic materials.

- PAT.241616 – Upgrade kit for planetary ball mills (2022)
- PAT.240692 – Hydrogen storage vessel (2022)
- PAT.240429 – Vial for planetary ball mill (2021)
- PAT.231933 – Method for intensification of hydrogen absorption and desorption (2020)

Recipient of the Medal of the Commission of National Education (2023).

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Supervised 2 completed PhD theses. Conducted 7 PhD reviews (including 4 international) and 2 habilitation reviews in the last five years.

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Dr habil. Wojciech Jerzy Stępniowski assoc. prof., 0000-0002-5251-6901

Position, management function

Associate professor

Scientific discipline represented (scientific disciplines %)

Materials science & engineering, 100%

Area of scientific interest

Corrosion, electrochemistry, carbon dioxide reduction, copper, copper alloys

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Member of Doctoral School Council, since 2023

Member of the Materials Science & Engineering Discipline Council, since 2021

Member of the Scientific Council of Warsaw Institute of Technology, Łukasiewicz Research Network, 2021 - 2024

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. 2022/47/I/ST5/00369, NCN / OPUS LAP / Electrochemically grown bimetallic Cu-Zn nanostructured catalysts for efficient electrochemical carbon dioxide reduction into added-value chemicals / 30.01.2024 – 29.01.2028, **Principal Investigator**, 1 700 520 PLN (project polsko-słoweński)
2. PPN/PPO/2019/1/00003/U/0001, NAWA / Polskie Powroty 2019 / Nanostructured anodic oxides grown on copper for carbon dioxide reduction reaction / 01.01.2020 – 30.06.2024, **Principal Investigator**, 2 213 251 PLN
3. 2022/06/X/ST5/00386, NCN / MINIATURA / AA 7075 anodizing in sulfiric-citric acid solution, with molybdenates as additives, as a green alternative for hexavalent chromium technology in corrosion protection / 03.09.2022 – 02.12.2023, **Principal Investigator**, 49 995 PLN

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

71 papers, H =30, 2353 citations

Most relevant papers:

1. Giziński, D.; Brudzisz, A.; Lee, J.; Harishchandre, R.; Choi, J.; Stępniowski, W.J.; Ziegler, K.J. (2025) Exploring the Impact of Chelating Agents on Copper Oxide Layer Formation and Morphology. ACS Inorganic Chemistry, 64 (15), 7437-7449.
2. Anioł, W.J.; Dobroń, P.; Tomczyk, K.; Stępniowski, W.J. (2025) Nanostructures Formed by Brass Electrochemical Oxidation—Fabrication Strategies and Emerging Applications. Materials, 18 (8) 1728
3. Tomczyk, K.; Stępniowski, W.J. (2024) Incorporation of Anions into Anodic Alumina—A New Track in Cr (VI) Anodizing Substitution? Materials, 17 (12) 2938

4. Giziński, D.; Najderek, M.; Brudzisz, A.; Lee, J.; Choi, J.; Stępniowski, W.J. (2024) Surface reorganization of oxide-derived Cu-M (M= Zn, Ag) bimetallic catalysts in CO2 electroreduction environment. Surfaces and Interfaces, 44, 103692.
5. Brudzisz, A.; Giziński, D.; Lee, J.; Ibrahim, M.; Gocman, K.S.; Choi, J.; Stępniowski, W.J. (2023) Electrochemical oxidation of brass in electrolytes with different viscosities. Electrochimica Acta, 447, 143353
6. Brudzisz, A.; Giziński, D.; Liszewska, M.; Wierzbicka, E.; Tiringer, U.; Taha, S.A.; Zając, M.; Orzechowska, S.; Jankiewicz, B.; Taheri, P.; Stępniowski, W.J. (2023) Low-voltage anodizing of copper in sodium bicarbonate solutions. Electrochimica Acta, 443, 141918
7. Giziński, D.; Mojsilović, K.; Brudzisz, A.; Tiringer, U.; Vasilić, R.; Taheri, P.; Stępniowski, W.J. (2022) Controlling the morphology of barrel-shaped nanostructures grown via CuZn electro-oxidation. Materials, 15 (11), 3961
8. Brudzisz, A.; Giziński, D.; Stępniowski, W.J. (2021) Incorporation of ions into nanostructured anodic oxides—Mechanism and functionalities. Molecules, 26 (21), 6378.
9. Brudzisz, A.; Giziński, D.; Wierzbicka, E.; Karczewski, K.; Tiringer, U.; Taheri, P.; Stępniowski, W.J. (2021) Pom-pom-like nanowire clusters prepared by potentiostatic oxidation of copper in NH4HCO3 solution. Surface and Coatings Technology, 425, 127674
10. Stępniowski, W.J.; Wang, K.K.; Chandrasekar, S.; Paliwoda, D.; Nowak-Stępniowska, A.; Misiolek, W.Z. (2020) The impact of ethylenediaminetetraacetic acid (EDTA) additive on anodization of copper in KHCO3 – hindering Cu2+ re-deposition by EDTA influences morphology and composition of the nanostructures. Journal of Electroanalytical Chemistry, 871, 114245
11. Giziński, D.; Brudzisz, A.; Santos, J.S.; Trivinho-Strixino, F.; Stępniowski, W.J.; Czujko, T. (2020) Nanostructured Anodic Copper Oxides as Catalysts in Electrochemical and Photoelectrochemical Reactions. Catalysts, 10, 1338
12. Stępniowski, W.J.; Misiołek, W.Z. (2020) The influence of electrolyte usage on the growth of nanostructured anodic films on copper in sodium carbonate aqueous solution. Journal of Electroanalytical Chemistry 857, 113491.
13. Stępniowski, W.J.; Paliwoda, D.; Abrahami, S.T.; Michalska-Domańska, M.; Landskron, K.; Buijnsters, J.G.; Mol, J.M.C.; Terryn, H.; Misiołek, W.Z. (2020) Nanorods grown by copper anodizing in sodium carbonate. Journal of Electroanalytical Chemistry 857, 113628.
14. Stępniowski, W.J.; Yoo, H.; Choi, J.; Norek, M.; Jóźwik, P.; Misiołek, W.Z. (2019) Fabrication and characterization of oxide nano-needles formed by copper passivation in sodium hydroxide solution. Thin Solid Films, 671, 111-119.
15. Stępniowski, W.J.; Yoo, H.; Choi, J.; Chilimoniuk, P.; Karczewski, K.; Czujko, T. (2019) Investigation of oxide nanowires growth on copper via passivation in NaOH aqueous solution. Surfaces and Interfaces, 14, 15-18.
16. Stępniowski, W.J.; Paliwoda, D.; Chen, Z.; Landskron, K.; Misiolek, W.Z. (2019) Hard anodization of copper in potassium carbonate aqueous solution. Materials Letters 252, 182-185.
17. Stepniowski, W.J.; Moneta, M.; Karczewski, K.; Michalska-Domanska, M.; Czujko, T.; Mol, J.M.C.; Buijnsters, J.G. (2018) Fabrication of copper nanowires via electrodeposition in anodic aluminum oxide templates formed by combined hard anodizing and electrochemical barrier layer thinning. Journal of Electroanalytical Chemistry 809, 59-66.

Education activities *(modules, average number of hours of classes, in the last 5 years)*
Corrosion research in materials engineering Anodic oxides on copper and copper alloys – fabrication, characterization, and applications Anodization of aluminum alloys
Achievements *(awards, distinctions, patents in the last 5 years)*
1. Robert Kersman Award for the Best Paper at the 2023 conference (Aluminum Anodizing Council Conference 2023, Seattle-Bellevue, WA, USA 10-12 October 2023)
Experience in supervisor and reviewing work *(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)*
Reviewed doctorates: 2 Reviewed habilitations: 6
Contact
Place of work: building no./room no.: 5/208 and 24/021 Tel.:+ 48 608812076 Email: wojciech.stepniowski@wat.edu.pl

Scientific Business Card

Title/degree Name and Surname, No ORCID

Ph.D., D.Sc., Eng. Paweł Baranowski, 0000-0002-5320-9479

Position, management function

Associate Professor

Scientific discipline represented (scientific disciplines %)

Engineering Mechanics (100%)

Area of scientific interest

Improvement of modern engineering tools and software for the assessment of military structures and infrastructure. Research on cellular structures in terms of energy absorption. Modelling and simulation of highly dynamic phenomena.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

National organizations and associations:

1. 2010 – present; member of the Polish Association for the Promotion of Computer Engineering Systems ProCAx (since 2010).
2. 2015 – present; member of the Polish Society for Computer Methods in Mechanics (PTMKM).
3. 2019 – present; member of the Computational Methods Section (MO) of the Mechanics Committee of the Polish Academy of Sciences.

International societies:

1. 2022 – present; member of The International Association of Protective Structures (a society bringing together scientists and researchers in the field of protective structures and related research

Membership in Organizing Committees (OC) at conferences on computer methods and experimental research:

- Computer Techniques in Engineering 2018 - TKI'2018, Mikołajki, Poland, October 16-19, 2018: scientific secretary of the conference.

Co-organizer and co-chair of thematic sessions at conferences

- 4th Polish Congress of Mechanics and 23rd International Conference on Computer Methods in Mechanics; session MS19. Krakow, Poland, September 8-12, 2019. Safety Aspects Under Dynamic Loadings: Numerical Design and Experiment organized by: P.W. Sielicki, P. Baranowski, and G. Sławiński.
- 24th International Conference on Computer Methods in Mechanics (CMM) and the 42nd Solid Mechanics Conference (SolMech): session S17. Świnoujście, Poland, September 5-8, 2022. Computational and experimental advanced mechanics in engineering applications organized by: J. Małachowski, P.W. Sielicki, P. Baranowski, T. Gajewski, N. Gebbeken.
- 11th International Conference on Experimental Vibration Analysis of Civil Engineering Structures, July 2-4, 2025, SS43 - Numerical simulations and experimental mechanics in terms of impulse loads organized by: Pawel Baranowski, Miroslaw Bocian, Krzysztof Jamroziak, Jerzy Malachowski, Piotr W. Sielicki.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Project No. B-PRJ-RT-797, 2022–2025, Additive Manufacturing of Metallic Auxetic Structures and Materials for Lightweight Armor (AMALIA), funded by the European Defense Agency; coordinator from the Military University of Technology and leader of the Polish team in the project.
2. Project No. 101006687, 2021–2024, MicrovehicLE fOr staNd-Alone and shaReD mObility – LEONARDO, Horizon 2020, European Commission, contractor.
3. Project No.: POIR.04.02.00-14.A003/16-00, 2016–2022; European Plate Observation System (EPOS), funded under Measure 4.2 of the Intelligent Development Operational Program (EU); leader of the Mechanical Engineering Department team on behalf of WAT.
4. Project No.: CuBR/III/6/NCBR/2017, KGHM-BZ-U-0150-2017, 2017–2021; Designing blasting metrics using a computer tool developed for the mining and geological conditions of copper ore mines (PROMETEST): NCBiR/KGHM, coordinator on behalf of WAT.
5. Project No. DOB-SZAFIR/02/A/002/02/2021, 2022 – present; Mobile disinfection system for medical protection of the Polish Armed Forces in counteracting SARS-CoV-2, NCBiR, contractor.
6. Project No. POWR.03.05.00-00-CW07/20, 2021 – present; Knowledge Center on Accessibility to Transport and Mobility for People with Special Needs (CWOD), financed by the European Social Fund, contractor.
7. Manager of three university research grants 2021, 2023, and 2025
8. Project No. 101216790, 2025 – present, Safe and Effective Decommissioning of Arch Supports, European Commission, coordinator on behalf of WAT.

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Hirsch Index

- Scopus: 27, number of publications: 77, number of citations: 1739.
- Web of Science – synchronization issues for several years, database moderators unable to assist with this issue

Top 10 publications from the last 5 years:

1. Baranowski P., Kucewicz M., Płatek P., Kappe K., Cieplak K., Małachowski J., 2025, *Numerical and experimental evaluation of maraging steel cellular topologies for ballistic panel design*, International Journal of Impact Engineering, 206, 105447.
2. Baranowski P., Kucewicz M., Janiszewski J, 2024, *JH-2 constitutive model of sandstone for dynamic problems*, Scientific Reports, 14 (1), 3339.
3. Kucewicz M., Baranowski P., Mazurkiewicz Ł., Małachowski J., 2023, Comparison of selected blasting constitutive models for reproducing the dynamic fragmentation of rock, International Journal of Impact Engineering, 173, 104484.
4. Baranowski P., Kucewicz M., Pytlik M., Małachowski J., 2022. S*hock-induced fracture of dolomite rock in small-scale blast tests*. Journal of Rock Mechanics and Geotechnical Engineering, Volume 14, Issue 6, December 2022, Pages 1823-1835.
5. Kucewicz M., Baranowski P., Małachowski J., 2021. *Dolomite fracture modeling using the Johnson-Holmquist concrete material model: Parameter determination and validation*. Journal of Rock Mechanics and Geotechnical Engineering, 13 (2), pp. 335-350
6. Pająk, M., Baranowski P., Janiszewski, J., Kucewicz M., Mazurkiewicz, Ł., Łaźniewska-Piekarczyk, B., 2021. *Experimental testing and 3D meso-scale*

numerical simulations of SCC subjected to high compression strain rates. Construction and Building Materials, 302, 124379.

7. Baranowski P., Kucewicz M., Małachowski J., Sielicki, P.W., 2021. *Failure behavior of a concrete slab perforated by a deformable bullet*. Engineering Structures, 245, 112832.
8. Baranowski P., Kucewicz M., Gieleta R., Stankiewicz M., Konarzewski M., Bogusz P., Pytlik M., Małachowski J., 2020. *Fracture and fragmentation of dolomite rock using the JH-2 constitutive model: Parameter determination, experiments and simulations*. International Journal of Impact Engineering, 140, 103543.
9. Baranowski P., Mazurkiewicz Ł., Małachowski J., Pytlik M., 2020. *Experimental testing and numerical simulations of blast-induced fracture of dolomite rock*. Meccanica, 55 (12), pp. 2337-2352.
10. Kucewicz M., Baranowski P., Małachowski J., 2020. *Determination and validation of Karagozian-Case Concrete constitutive model parameters for numerical modeling of dolomite rock*. International Journal of Rock Mechanics and Mining Sciences, 129, 104302.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Type of classes: L – lecture, T – classes, L – laboratory, P – project, S – seminar.

1. Modelowanie i symulacja sprzętu rehabilitacyjnego, W,C,L,P.
2. Seminarium Dyplomowe, S.
3. Seminarium Przedyplomowe, S.
4. Engineering Mechanics 2, W, C.
5. Komputerowe wspomaganie obliczeń inżynierskich,W, L, P.
6. Computer Aided Engineering, W, P.
7. Wstęp do symulacji sprzętu rehabilitacyjnego, W.
8. Symulacje dynamicznych zagadnień mechaniki I, W,L.
9. Projektowanie uniwersalne w modelowaniu i analizach numerycznych, W

Subjects on Doctoral School: none
Average number of hours: 283

Achievements

(awards, distinctions, patents in the last 5 years)

- 2022: Award of the Minister of National Defense for significant achievements in scientific activity
- 2022: Professor Michał Życzkowski Second Degree Scientific Award of the Mechanics Committee of the Polish Academy of Sciences (Warsaw, May 15, 2022).
- 2020: Medal for services to the Faculty of Mechanical Engineering, Military University of Technology (Warsaw, February 24, 2020).
- 2020: Diploma for outstanding publications in the field of Mechanical Engineering in 2019, Military University of Technology (Warsaw, June 2020).
- 2020: Patent, Explosives rack that does not transfer explosion energy, PL 439136

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of promoted doctors: 0 (5 doctoral students currently working on their dissertations)

Number of doctoral student reviews: 5

Number of reviews in habilitation proceedings: 2

Number of reviews in professorial proceedings: 0

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Dr hab. inż. Tadeusz Dziubak, prof. WAT, 0000-0002-1609-3518

Position, management function

University professor

Scientific discipline represented (scientific disciplines %)

Mechanical Engineering

Area of scientific interest

Research on the air filtration process in two-stage filters, including: numerical and experimental studies of reverse cyclones with tangential inlet and axial flow cyclones in terms of efficiency, filtration accuracy, pressure drop, and the impact of dust extraction from inertial dust collectors on filtration characteristics. Experimental studies of multi-layer filter beds in terms of efficiency, filtration accuracy, pressure drop, and dust absorption. Experimental studies of the impact of air filter pressure drop on engine performance and exhaust gas composition.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

1) Vice-Dean for Scientific Affairs at the Faculty of Mechanical Engineering of the Military University of Technology for the period from October 1, 2020, to September 30, 2024.
2) Member of the Scientific Discipline Council “Mechanical Engineering” for the term ending August 31, 2024.
3) Chair of the Science and Development Committee of the Scientific Discipline Council for Mechanical Engineering for the term of office from November 1, 2019, to September 30, 2024.
4) Representative of the Dean of the Faculty of Mechanical Engineering for cooperation with the socio-economic environment for the period October 1, 2020-September 30, 2024.
5) Chair of the Science and Development Committee of the Faculty of Mechanical Engineering for the term of office from October 1, 2016, to September 30, 2020.
6) Member of the Senate Committee for Science for two terms: October 1, 2016-September 30, 2020, and October 1, 2021-September 30, 2024.
7) Member of the Honorary Degrees Committee of the Military University of Technology for the period 01.10.2020-30.09.2024 and 01.10.2025-30.09.2028.
8) Member of the Library Council for the term 2021-2024.
9) Member of the Doctoral School Council for the 2021-2024 term.
10) Member of the Senate of the Military University of Technology for the term 01.10.2016-30.09.2020.
11) Member of the Military University of Technology Senate Statute Committee for the term of office from October 1, 2016, to September 30, 2020.
12) Member of the Faculty Committee for the evaluation of the quality of diploma theses for the period 01.10.2020-30.09.2024 and 01.10.2024-30.09.2028.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1) DOB-SZAFIR/02/A/018/04/2021 - NCBiR “Mobile system for combating micro and mini UAVs.” Implementation period: August 1, 2023-July 31, 2027, Consortium: WAT (leader), Flytronic, AMZ KUTNO. Research task - Consultations on the design of the command module, the design of the command and detection module vehicle - contractor.
2) TexKap - European Defense Agency EDA “New Textiles for Kinetic Absorption and Protection against Chemical and Biological Threats.” Implementation period: January 6, 2025-May 31, 2027. Consortium leader: Łukasiewicz Research Network – Łódź Institute of Technology. Research task – Development of a research methodology for newly created textile materials resistant to kinetic penetration and biological and chemical threats – contractor.
3) CALIPSO - EDF-2023-RA-SI-ENERENV-IPS Innovative propulsion systems for land and sea defense applications. Agreement No.: 101168041-CALIPSO-EDF-2023-RA-SI, PRUE/31-354/2024/WAT. Implementation period: December 2024 - November 2027. Research task - analysis of the latest designs and solutions for filtration systems, including air and alternative fuels in the land domain - contractor.
4) University Research Grant UGB No. 531-000019-W100-22. Assessment of the impact of selected operating parameters on the performance of internal combustion engines and hybrid drive systems. Research task No. 1: Assessment of the impact of selected parameters of a straight-through cyclone on its filtration properties and the quality of air entering the engine. WAT Warsaw 2025. Implementation period: January 2, 2025-December 31, 2025 – contractor.
5) University Research Grant UGB 22-759. Theoretical and experimental verification of criteria for selecting filter partitions for intake air filters in motor vehicles. WAT Warsaw 2021. Implementation period: January 2, 2021-December 31, 2021 – project manager.
6) University Research Grant UGB 881/2021. Experimental testing of PowerCore filter cartridges. WAT Warsaw 2020. Implementation period: January 2, 2020-December 31, 2020 – project manager.

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Analysis of citations of publications found in databases:

Web of Science
Number of publications – 29
Number of citations – 365
Number of citations excluding self-citations – 281
Hirsch index – 14

Scopus
Number of publications – 29
Number of citations – 407
Number of citations excluding self-citations – 316
Hirsch index – 14

Google scholar
Number of publications – 141
Number of citations – 850
Hirsch index – 15

1. Dziubak T., Karczewski M., Chmaj G.: Experimental evaluation of the influence of blends of aviation fuel with RME on the performance of an engine with a common-rail power system. Fuel Processing Technology 2025, 275. 108254. https://doi.org/10.1016/j.fuproc.2025.108254.
2. Dziubak T, Ślęzak M. Characteristics of pollutants emitted by motor vehicles and their impact on the environment and engine operation. Combustion Engines. 2025, 200(1) 37-55. https://doi.org/10.19206/CE-194628.
3. Dziubak S., Dziubak T.: Experimental study of an axial flow cyclone with ongoing dust removal from a settling tank. Chemical Engineering & Processing: Process Intensification 209 (2025) 110167. https://doi.org/10.1016/j.cep.2025.110167.
4. Dziubak T.: Research into a Two-Stage Filtration System of Inlet Air to the Internal Combustion Engine of a Motor Vehicle. Energies 2024, 17, 6295. https://doi.org/10.3390/en17246295.
5. Dziubak T.: Experimental Dust Absorption Study in Automotive Engine Inlet Air Filter Materials. Materials 2024, 17, 3249. https://doi.org/10.3390/ma17133249.
6. Dziubak S., Małachowski J., Dziubak T., Tomaszewski M.: Numerical studies of an axial flow cyclone with ongoing removal of separated dust by suction from the settling tank. Chemical Engineering Research and Design 208 (2024) 29–51. https://doi.org/10.1016/j.cherd.2024.05.044.
7. Dziubak T.: Experimental Testing of Filter Materials for Two-Stage Inlet Air Systems of Internal Combustion Engines. Energies 2024, 17, 2462. https://doi.org/10.3390/en17112462.
8. Chojnowski J., Dziubak T.: Multi-Criteria Analysis of Semi-Trucks with Conventional and Eco-Drives on the EU Market. Energies 2024, 17, 1018. https://doi.org/10.3390/en17051018.
9. Dziubak T., Szczepaniak P.: Modelling Internal Leakage in the Automatic Transmission Electro-Hydraulic Controller, Taking into Account Operating Conditions. Energies 2023, 16, 7667. https://doi.org/10.3390/en16227667.
10. Dziubak T., Dziubak S., Tomaszewski M.: Numerical study of the effect of axial cyclone inlet velocity and geometrical parameters on separation efficiency and pressure drop. Powder Technology, 427, 2023, 118692. https://doi.org/10.1016/j.powtec.2023.118692.
11. Dziubak T.: Experimental Study of a PowerCore Filter Bed Operating in a Two-Stage System for Cleaning the Inlet Air of Internal Combustion Engines. Energies 2023, 16, 3802. https://doi.org/10.3390/en16093802.
12. Dziubak T.: Experimental Studies of PowerCore Filters and Pleated Filter Baffles. Materials 2022, *15*(20), 7292; https://doi.org/10.3390/ma15207292.
13. Dziubak T., Karczewski M.: Experimental Studies of the Effect of Air Filter Pressure Drop on the Composition and Emission Changes of a Compression Ignition Internal Combustion Engine. Energies 2022, 15, 4815. https://doi.org/10.3390/en15134815.
14. Dziubak T.: Experimental Investigation of Possibilities to Improve Filtration Efficiency of Tangential Inlet Return Cyclones by Modification of Their Design. Energies 2022, 15, 3871. https://doi.org/10.3390/en15113871.
15. Dziubak T., Karczewski M.: Experimental Study of the Effect of Air Filter Pressure Drop on Internal Combustion Engine Performance. Energies 2022, 15, 3285. https://doi.org/10.3390/en15093285. 30.04.2022.

16. Dziubak T., Dziubak S.D.: A Study on the Effect of Inlet Air Pollution on the Engine Component Wear and Operation. Energies 2022, 15, 1182. https://doi.org/10.3390/en15031182.
17. Dziubak, T.: Theoretical and Experimental Studies of Uneven Dust Suction from a Multi-Cyclone Settling Tank in a Two-Stage Air Filter. Energies 2021, 14, 8396.https://doi.org/10.3390/en14248396. 13.12.2021.
18. Dziubak T., Bąkała L., Dziubak S.D., Sybilski K., Tomaszewski M.: Experimental Research of Fibrous Materials for Two-Stage Filtration of the Intake Air of Internal Combustion Engines. Materials 2021, 14(23), 7166. https://doi.org/10.3390/ma14237166.
19. Dziubak T., Boruta G.: Experimental and Theoretical Research on Pressure Drop Changes in a Two-Stage Air Filter Used in Tracked Vehicle Engine. Separations 2021, 8, 71. https://doi.org/10.3390/separations8060071. (Udział 70%).
20. Dziubak T.: Experimental Studies of Dust Suction Irregularity from Multi-Cyclone Dust Collector of Two-Stage Air Filter. Energies 2021, *14*(12), 3577; https://doi.org/10.3390/en14123577.
21. Dziubak T., Bąkała L.: Computational and Experimental Analysis of Axial Flow Cyclone Used for Intake Air Filtration in Internal Combustion Engines. *Energies* 2021, *14*(8), 2285; https://doi.org/10.3390/en14082285.
22. Dziubak T.: Material Properties Analysis with Addition of Nanofibers for Air Intake Filtration in Internal Combustion Engines. International Journal of Automotive and Mechanical Engineering (IJAME). 2021 18, (01), 8621-8636: https://doi.org/10.15282/ijame.18.1.2021.21.0656.
23. Dziubak T., Wysocki T., Dziubak S.: Selection of vehicles for fleet of transport company on the basis of observation of their operational reliability. Eksploatacja i Niezawodnosc – Maintenance and Reliability 2021; 23 (1): 184-194, https://doi.org/10.17531/ein.2021.1.19.
24. Dziubak T., Dziubak S.D.: Experimental Study of Filtration Materials Used in the Car Air Intake, *Materials. 13*(16), 3498. (2020). https://doi.org/10.3390/ma13163498.
25. Dziubak T.: Experimental research on separation efficiency of aerosol particles in vortex tube separators with electric field. Bulletin of The Polish Academy of Sciences Technical Sciences, Vol. 68, No. 3, 2020. 503-516. DOI:10.24425/bpasts.2020.133385.
26. Dziubak T., Bąkała L., Karczewski M., Tomaszewski M.: Numerical research on vortex tube separator for special vehicle engine inlet air filter. Separation and Purification Technology. 237 (2020) 116463. https://doi.org/10.1016/j.seppur.2019.116463.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Courses offered in the field of Mechanics and Machine Design and Logistics:
Technical operation of cars, Operation of military vehicles, Theory of internal combustion engines, Construction of internal combustion engines, Drive engines for engineering machines, Engines for motor vehicles, Internal combustion engines and hybrid drive systems, Filtration and neutralization of exhaust gases in power engineering, Operation of transport equipment, Mechatronic control systems in cars,

Basics of operating fluid filtration, Basics of diagnostics, Car diagnostics, Electrical engineering and car electronics, Production and repair of motor vehicles, Car maintenance and repair, Development of vehicle drive systems, Diploma seminars.
Courses taught at SDR: Basics of intake air filtration for internal combustion engines in inertial filters, Basics of intake air filtration for internal combustion engines in inertial filters.
Average number of hours of classes: 2019/2020 – 352, 2020/2021 – 346, 2021/2022 – 326, 2022/2023 – 245, 2023/2024 – 286, 2024/2025 – 292.

Achievements
(awards, distinctions, patents in the last 5 years)

1) Team award from the Rector-Commandant of the Military University of Technology (Dziubak T., Karczewski M., Szamrej G., Chojnowski J.) for achievements in scientific activity resulting from research in the field of reducing harmful exhaust emissions and greenhouse gases by modern compression ignition engines. WAT Warsaw 2023.
2) Place on the “Ranking World's Top 2% Scientists” list – a list of the most frequently cited scientists from around the world, published on September 16, 2024.
3) Place on the “Highly Ranked Scholar GPS 2024” list – a list of the top 0.05% of all scientists worldwide according to the latest Scholar GPS 2024 rankings published on May 6, 2025.
4) Diploma of recognition from the Dean of the Faculty of Mechanical Engineering of the Military University of Technology for outstanding publication activity in the KI Criterion in the scientific discipline of “Mechanical Engineering” in the evaluation for the years 2017-2021. WAT 2022.
5) Gold Cross of Merit – 2021
6) Gold Medal “For Merit to the Military University of Technology” – 2020.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

1) Supervisor of three completed doctoral dissertations: Sebastian Szwedkowicz – 2015. Paweł Przemysław Szczepaniak – 2016, Janusz Chojnowski – 2024.
2) Supervisor of three doctoral theses at the WAT Doctoral School: Szamrej Grzegorz, Dopieralski Marcin, Dębowski Karol.
3) Reviewer of two doctoral theses: Paweł Abratowski – 2018, Konrad Kuźma – 2019.
4) Member of the habilitation committee in the promotion procedure of Dr. Eng. Piotr Wróblewski, 2023.

Contact

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Scientific Business Card

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Dr habil. Eng. Jacek JANISZEWSKI, 0000-0003-3783-8774

Position, management function

University Professor, Head of Department

Scientific discipline represented (scientific disciplines %)

Mechanical Engineering (100%)

Area of scientific interest

Research on Mechanical Materials Properties under Dynamic Loading Conditions. Material and Technological Aspects of Manufacturing Weapon and Ammunition Components. Terminal Ballistics.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

1. Member of the Discipline Council for Mechanical Engineering at the Military University of Technology (WAT)
2. Member of the Scientific Council of the Institute of Fundamental Technological Research, Polish Academy of Sciences (IPPT PAN), 2022–2024
3. Member of the Experimental Mechanics Section of the Committee on Mechanics, Polish Academy of Sciences (PAN), since February 19, 2025
4. Chair of the Warsaw Branch of the Polish Society of Theoretical and Applied Mechanics (PTMTS), 2019–2024
5. Member of the Recruitment Subcommittee for Doctoral School Candidates at the Military University of Technology (WAT)

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. **B PRJ-RT-1042** – *Reverse Calculation Method in Interior Ballistics and Improvement of Multiphysics Models (RECBALL)* Client: European Defence Agency (EDA) Role: Researcher Duration: 20 June 2023 – 18 June 2027
2. **B-PRJ-RT-797 (PUM 09-524/2022/WAT)** – *Additive Manufacturing of Metallic Auxetic Structures and Materials for Lightweight Armour (AMALIA)* Client: European Defence Agency (EDA) Role: Researcher Duration: 2 October 2022 – 30 September 2025
3. **TECHMATSTRATEG2/410049/12/NCBR/2019** – *Advanced Iron- and Copper-Based Alloys for the Production of Components with Designed Structure and Properties Using Additive Manufacturing Technologies* Client: National Centre for Research and Development (NCBR) Role: Principal Investigator Duration: 1 January 2020 – 30 June 2023
4. **TECHMATSTRATEG1/349146/13/NCBR/2017 (WAT Project PPFN/34-196/2018)** – *Nanocrystalline and Amorphous Structured Materials for Shaped Charge Liners Used in the Mining Industry* Client: National Centre for Research and Development (NCBR) Role: Project Leader (WAT) Duration: 1 March 2018 – 28 February 2022
5. **GBMON/13-988/2018/WAT** – *Analysis of the Potential Use of Pulsed Plasma and Electric Field Sources in Advanced Ammunition Designs* Client: Ministry of

National Defence (MON) Role: Principal Investigator Duration: 15 June 2018 – 14 June 2022

6. **2017/27/B/ST8/03074** – *Study of the Effect of Strain Rate on the Elasto-Plastic Properties of Gumo Metal under Quasi-Static and Dynamic Loading Using Field Optical Methods* Client: National Science Centre (NCN) Role: Researcher Duration: 20 June 2018 – 19 June 2023

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Author or co-author of 118 scientific publications, of which 50 are indexed in the Web of Science and 72 in Scopus. The H-index is 14 according to Web of Science and 17 according to Scopus.

1. Kopeć, M., Łazińska, M. & **Janiszewski, J.**, (2025). High strain rate response of CP-titanium under low-temperature conditions: experiment and modeling. *Arch. Civ. Mech. Eng.* **25**, 261. https://doi.org/10.1007/s43452-025-01317-0
2. Kovalchuk, D.V., Savvakin, D.G., **Janiszewski, J.** et al., (2025). Terminal ballistic effects for 3D-printed multi-layered material consisting of Ti-6Al-4V alloy, metal matrix composite and porous titanium. *Sci Rep 15, 12767*. https://doi.org/10.1038/s41598-025-97087-z
3. Markovsky, Pavlo E., **Janiszewski, Jacek**, Stasiuk, Oleksandr O., Savvakin, Dymitro G., Oryshych, Denys V. and Dziewit, Piotr, (2025). Mechanical energy absorption capacity of the porous Ti-6AI-4V alloy under quasi-static and dynamic compression, *Bulletin of the Polish Academy of Sciences Technical Sciences*, Vol. 73, No. 1, pp. e151959, https://doi.org/10.24425/bpasts.2024.151959.
4. Kopec, M., Xiaochuan Liu, Gorniewicz, D., Modrzejewski, P., Zasada d., Jozwiak, S., **Janiszewski, J.**, Kowalewski, Z. L. (2024). Mechanical response of 6061-T6 aluminium alloy subjected to dynamic testing at low temperature: Experiment and modelling. *International Journal of Impact Engineering*, Volume 185, 104843, https://doi.org/10.1016/j.ijimpeng.2023.104843.
5. Markovsky, P. E., **Janiszewski, J.**, Stasiuk, O. O., Savvakin, D. G., Oryshych, D. V., & Dziewit, P. (2023). Mechanical Energy Absorption Ability of Titanium-Based Porous Structures Produced by Various Powder Metallurgy Approaches. *Materials*, *16*(9), 1–24. https://doi.org/10.3390/ma16093530.
6. Pająk, M., & **Janiszewski, J.** (2023). Influence of aggregate and recycled steel fibres on the strain rate sensitivity of mortar and concrete. *Construction and Building Materials*, *363*(August 2022), 1–19. https://doi.org/10.1016/j.conbuildmat.2022.129855.
7. Markovsky, P. E., **Janiszewski, J.**, Savvakin, D. G., Stasiuk, O. O., Cieplak, K., Baranowski, P., & Prikhodko, S. V. (2022). Mechanical behavior of bilayer structures of Ti64 alloy and its composites with TiC or TiB under quasi-static and dynamic compression. *Materials & Design*, 223, 111205. https://doi.org/10.1016/j.matdes.2022.111205.
8. Golasiński, K. M., **Janiszewski, J.**, Sienkiewicz, J., Płociński, T., Zubko, M., Świec, P., & Pieczyska, E. A. (2021). Quasi-Static and Dynamic Compressive Behavior of Gum Metal: Experiment and Constitutive Model. *Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science*, 52(10), 4558–4571. https://doi.org/10.1007/s11661-021-06409-z.

9. Wood, P., Rusinek, A., Platek, P., **Janiszewski, J.**, Sienkiewicz, J., Gunputh, U. F., Rajkowski, K., & Miguélez, M. H. (2021). High strain rate effect on tensile ductility and fracture of AM fabricated Inconel 718 with voided microstructures. *Materials and Design*, 208, 109908. https://doi.org/10.1016/j.matdes.2021.109908.
10. Platek, P., Sienkiewicz, J., **Janiszewski, J.**, & Jiang, F. (2020). Investigations on mechanical properties of lattice structures with different values of relative density made from 316L by selective laser melting (SLM). Materials, 13(9). https://doi.org/10.3390/ma13092204.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Metrology (Bachelor's degree program), *Metrology of Geometric Quantities in Manufacturing* (Master's degree program), *Manufacturing Engineering* (Bachelor's degree program), *Modern Manufacturing Techniques* (Master's degree program, postgraduate courses), *Weapon Maintenance Technology* (Integrated Master's degree program), *Weapon and Ammunition Manufacturing Technology* (Integrated Master's and postgraduate programs), *Material Testing Techniques* (Master's degree program), *Diploma Seminar* (Bachelor's and Master's degree programs), *Terminal Ballistics* (Integrated Master's degree program), ***Methods and Techniques of Material Testing*** **(Doctoral program).**

Average annual teaching load: 247 hours (145% of the standard teaching norm)

Achievements
(awards, distinctions, patents in the last 5 years)

1. Silver Medal "For Merits to the Military University of Technology" (2021).
2. Gold Badge "Distinguished Member of the Polish Society of Theoretical and Applied Mechanics" (2024).
3. Patent Pat.246887 – R. Panowicz, J. Janiszewski, M. Konarzewski: *Corrugated Projectile Body* (2023).
4. Patent Pat.246916 – R. Panowicz, J. Janiszewski, M. Konarzewski: *Projectile Body with Symmetrical Fragmentation* (2023)
5. Patent Pat.246917 – R. Panowicz, J. Janiszewski, M. Konarzewski: *Polygonal Projectile Body* (2023).
6. Patent Pat.247071 – W. Burian, J. Kulasa, J. Janiszewski, K. Cieplak, M. Zielenkiewicz, M. Magier, J. Lachmajer, M. Mazurkiewicz, M. Pytlik, M. Rotkegel, J. Sobala, M. Szastok, J. Szymała, A. Żak, J. Marcisz: *Explosive Charge with Shaped Charge Effect for Fragmentation of Oversized Rocks* (2021).

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Supervised PhD Candidates: 3 doctoral graduates

Reviewer:

- 2 doctoral dissertations (for the Air Force Institute of Technology in 2022 and Wrocław University of Science and Technology in 2023/24).
- 1 review in a habilitation procedure (2023).

Contact
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Scientific Business Card

Title/degree Name and Surname, No ORCID

PhD, DSc, PEng Adam Kozakiewicz, https://orcid.org/0000-0002-1607-5715

Position, management function

Acciociate Professor

Scientific discipline represented (scientific disciplines %)

mechanical engineering (100%)

Area of scientific interest

Turbine engines, control turbine engines , operation and diagnostics of rotating machines

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Member of Technical Subcommittee No. 6 for military aviation armament and equipment, PKN

Member of the team responsible for defining criteria and rules for the periodic evaluation of academic teachers at the Military University of Technology

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

2025 – UGB Nr 531-000039-W200-22 - Construction of a combustion chamber model and analysis of cold flow in a turbine engine. – funding by WAT

2024 – UGB Nr 733 /2024 - Analysis of the F-16 aircraft engine fan system as a function of variable inlet flow distortion – funding by WAT

2024 – AKT 3008-15 DS. 23.2022 – Determining the circumstances of damage to RD-33 engines in MiG-29 aircraft – financing by the Ministry of National Defense

2023 – UGB WNIOSEK Nr 822 /2023 - Analysis of the impact of the inlet system on the instability of the axial compressor of a turbine engine. – funding by WAT

2022 – UGB Nr 781 /2022 - Construction of a parametric model of an aircraft turbine engine compressor and its numerical analysis using artificial neural networks to optimize structural components. – funding by WAT

2021 – ACT 4031-15 DS. 13.2021 - Determination of the causes of the shutdown of the W3 helicopter engine with side number 0819 – financing by the Ministry of National Defense

2021 – UGB Nr 22-898/2021 Numerical analysis of flow phenomena occurring in jet aircraft engine inlets caused by inlet vortex – funding by WAT

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Number of publications: 139, including 39 publications in the last 5 years, h-index = 7 (Web of Science), h-index = 6 (Scopus), most important publications in the last 5 years:

Kozakiewicz A., Jóźwiak S., Jóźwiak P., Kachel S., Material Origins of the Accelerated Operational Wear of RD-33 Engine Blades, Materials 2021, Volume 14, Issue 2, 336, https://doi.org/10.3390/ma14020336

Kozakiewicz A., Rafał Kieszek, Artificial Neural Network Structure Optimisation in the Pareto Approach on the Example of Stress Prediction in the Disk-Drum Structure of an Axial Compressor, Materials 2022, 15, 4451, https://doi.org/10.3390/ma15134451

Adam Kozakiewicz, Stanisław Kachel, Michał Frant and Maciej Majcher, Intake-System-Performance Stability as a Function of Flow Throttling, Energies 2022, 15, 6291, https://doi.org/10.3390/en15176291

Adam Kozakiewicz, Aleksandra Kołodziejska, Rafał Kieszek, Application of Laboratory Tests in Numerical Analysis for Exhaust Emissions in Business Jet Engines, Advances in Science and Technology Research Journal 2023, 17(4), 21–35, , https://doi.org/10.12913/22998624/167456

Stanisław Jóźwiak, Adam Kozakiewicz, Stanisław Kachel, Dariusz Zasada, Operational and Material Causes of High-Pressure Turbine Disc Damage in the RD-33 Engine, Materials 2023, 16, 5939. https://doi.org/10.3390/ma16175939, Published: 30 August 2023

Grzejszczak-Paczek, O.; Kozakiewicz, A. FSI Application in the Parametric Analysis of Blade–Disk Connection of Turbojet Engine Compressor, Appl. Sci. 2023, 13, 10960. Appl. Sci. 2023, 13, 10960., Published: 4 October 2023

Kozakiewicz A., Frant M., Majcher M., Adamczyk M., Analysis of the Impact of Aircraft Manoeuvring on Intake Disturbance, International Review of Aerospace Engineering (I.RE.AS.E), Vol. 16, N. 4 (2023), pp. 159-168

Ciałkowski M., Joachimiaka M., Mierzwiczak M., Frąckowiak A., Olejnik A. Kozakiewicz A., The analysis of the stability of the Cauchy problem in the cylindrical double-layer area, Archives of Thermodynamics, Vol. 44(2023), No. 4, 631–647, DOI: 10.24425/ather.2023.149735

Kozakiewicz A., Adamczyk M., Kieszek R., Application of Neural Network Models for Analyzing the Impact of Flight Speed and Angle of Attack on Flow Parameter Non-Uniformity in a Turbofan Engine Inlet Duct, Energies 2025, 18(8), 2064; pp. 1-15, https://doi.org/10.3390/en18082064

Education activities

(modules, average number of hours of classes, in the last 5 years)

Theory of aircraft engines, Propulsion systems control, Aircraft propulsion, 310 hours/year

Achievements

(awards, distinctions, patents in the last 5 years)

2020 - Gold Medal for Long Service

2021 - Medal of the National Education Commission

2025 - Gold Cross of Merit

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

number of promoted doctors 3, number of reviews doctoral students 5, in habilitation proceedings 1

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Prof. Lucjan Śnieżek, Ph.D., D.Sc, 0000-0002-1157-0565

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Mechanical Engineering

Area of scientific interest

Theoretical and experimental studies of the fatigue properties of structural materials, including materials obtained by detonation joining and additive techniques, as well as crack initiation and growth mechanisms, including dynamic surface plastic working. Predicting the fatigue life of welded and FSW joints.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

1. Chairman of the Senate Committee on Science,
2. Director of the Institute of Robots and Machine Design, Faculty of Mechanical Engineering, Military University of Technology.
3. Member of the Senate Committee on Development and Cooperation.
4. Member of the Disciplinary Council for Mechanical Engineering, Military University of Technology.
5. Vice-Rector for Development, Military University of Technology.
6. Chairman of the Intellectual Property Committee, Military University of Technology.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. UGB 708/2024, Development of Advanced Structural Materials and the Efficiency of Machine and Robot Control Systems, February 15, 2024 - December 31, 2024, University Research Grant – Principal Investigator.
2. UGB 830/2023, Development of Techniques for Joining Materials and Structural Elements, and Methods for Designing, Shaping, and Controlling Mobile Machines and Robots, February 15, 2023 - December 31, 2023, University Research Grant – Principal Investigator.
3. UGB 757/2022, Development of Manufacturing Techniques for Mechanical Structures and Machine Control Systems, February 15, 2022 - December 31, 2022, University Research Grant – Project Manager
4. GB 1/2018/205//DA, Ministry of National Defense, Research on Thermomechanical Phenomena Accompanying the Processes of Joining Light Alloys for Military Purposes, project implementation period: June 15, 2018 - June 14, 2022. Project awarded under the Program of the Minister of National Defense for the implementation of basic research – Project Manager.
5. TECHMATSTRATEG II/412341/8/NCBiR/2019 "Modern Material Technologies", Development of low-waste explosive cladding technology and processing technology for multi-layer, high-strength lightweight and super-light materials with reactive and functional layers, as well as sheets explosively clad with reactive metals and their alloys, July 1, 2019 - June 30, 2022 - contractor
6. PRELUDIUM 23 - NCN, Influence of manufacturing parameters on the low-cycle fatigue strength and fatigue cracking process of 17-4 PH steel components produced during

incremental extrusion (2024/53/N/ST8/02951) - Supervisor of the Project Manager, Katarzyna Jasik, M.Sc. Eng.

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

- Number of publication: over 200
- Index Hirscha: 17 (WoS), 19 (Scopus)

The most important publications in the last 5 years:

1. Zygmuntowicz J., Kosiorek M., Wachowski M., Śnieżek L., Szachogłuchowicz I., Piotrkiewicz P., Kaszuwara W., Konopka K., The Structural and Mechanical Properties of Al2O3–Ni Composites Obtained by Magnetic Field-Assisted Centrifugal Slip Casting, Materials 17, 3902, 2024, 140 pkt., doi: 10.3390/ma17163902,
2. Wachowski M., Zygmuntowicz J., Kosturek R., Śnieżek L., Piotrkiewicz P. Żurowski R., Korycka K., The influence of the metal phase of novel Al2O3/TiO2/TiAl2O5 composites obtained via a slip casting method, Bulletin of the Polish Academy of Sciences: Technical Sciences, 73/1, 2024, 100 pkt., doi: 10.24425/bpasts.2024.152213,
3. Jasik K., Śnieżek L., Kluczyński J., Łuszczek J., Grzelak K., Sarzyński B., Szachogłuchowicz I., 17-4 PH Steel Parts Obtained through MEX and PBF-LB/M Technologies: Comparison of the Structural Properties, Materials, 17/12, 2024, pp. 1-15, 140 pkt., doi.org/10.3390/ma17122801,
4. Szachogłuchowicz I., Śnieżek L., Wójcik A., Mechanical Properties of the AlCu4Mg1 Alloy Joint Manufactured by Underwater Friction Stir Welding, Materials, 17(8), 2024, pp. 1-17, 140 pkt., doi.org/10.3390/ma17081722,
5. Kosturek R., Śnieżek L., Torzewski J., Ślęzak T., Lewczuk R., Influence of post-weld explosive treatment on low cycle fatigue of AA7075-T651 friction stir welded joint, 2024, Theoretical and Applied Fracture Mechanics, Vol. 133, Part A, 2024, pp. 1-12, 100 pkt., doi: 10.1016/j.tafmec.2024.104574,
6. Kosturek R., Torzewski J., Śnieżek L., Study on Underwater Friction Stir Welding of AA7075-T651, Advances in Science and Technology Research Journal, 18 (8), 2024, pp. 191-203, 100 pkt., doi: 10.12913/22998624/193529,
7. Sarzyński B., Kluczyński J., Łuszczek J., Grzelak K., Szachogłuchowicz I., Torzewski J., Śnieżek L., Process Parameter Investigation and Torsional Strength Analysis of the Additively Manufactured 3D Structures Made of 20MnCr5 Steel, Materials, 16/5, 2023, pp. 1-16, 140 pkt., doi: 10.3390/ma16051877,
8. Ziółkowski W., Boroński D., Skibicki A., Stachowiak R., Kosturek R., Śnieżek L., Mechanical properties and microstructure of dissimilar S355/AA6061-T6 FSW butt joints, Materials, 16, 2023, pp. 1-23, 140 pkt., doi: 10.3390/ma16175950,
9. Kosturek, R., Ślęzak, T., Torzewski, J., Bucior, M., Zielecki, W., Śnieżek, L., Sęp, J., Effect of Shot Peening on the Low-Cycle Fatigue Behavior of an AA2519-T62 Friction-Stir-Welded Butt Joint, Materials, 16, 2023, pp.1-12, 140 pkt., doi: 10.3390/ma16227131,
10. Wachowski M., Zygmuntowicz J., Kosturek R., Piotrkiewicz P., Żurowski R., Więcław-Midor A., Śnieżek L., Study on manufacturing via slip casting and properties of alumina-titanium composite enhanced by thialite phase, Materials, 79, 16/1, 2023, pp. 1-13, 140 pkt., doi: 10.3390/ma16010079,
11. Grzelak K., Bielecki M., Kluczynski J., Szachogłuchowicz I., Śnieżek L., Torzewski J., Łuszczek J., Słoboda Ł., Wachowski M., Komorek Z., Małek M., Zygmuntowicz J., A Comparative Study on Laser Powder Bed Fusion of Differently Atomized 316L Stainless Steel, Materials, 15/14, 2022, pp. 1-19, 140 pkt., doi:10.3390/ma15144938,
12. Kosturek R., Torzewski J., Wachowski M., Śnieżek L., Effect of Welding Parameters on Mechanical Properties and Microstructure of Friction Stir Welded AA7075-T651 Aluminum Alloy Butt Joints, Materials, 15/17, 2022, pp. 1-15, 140 pkt., doi: 10.3390/ma15175950

13. Kosturek R., Torzewski J., Joska Z., Wachowski M., Śnieżek L., The influence of tool rotation speed on the low-cycle fatigue behavior of AA2519-T62 friction stir welded butt joints, Engineering Failure Analysis, 42, 2022, pp. 1-13, 100 pkt., doi:10.1016/j.engfailanal.2022.106756,
14. Wachowski M., Zygmuntowicz J., Kosturek R., Śnieżek L., Piotrkiewicz P., Properties of Al2O3/Ti/Ni Composite Obtained by Slip Casting with Different Metal Phase Content, Materials, 15/19, 2022, pp. 1-15, 140 pkt., doi:10.3390/ma15196514,
15. Kluczyński J., Śnieżek L., Grzelak L., Torzewski J., Szachogłuchowicz I., Wachowski M., The Influence of Process Parameters on the Low-Cycle Fatigue Properties of 316L Steel Parts Produced by Powder Bed Fusion, Metallurgical and Materials Transactions A, 54, 2022, pp. 196-210, 200 pkt., doi: 10.1007/s11661-022-06858-0,
16. Łuszczek K., Śnieżek L., Grzelak K., Kluczyński J, Torzewski J., Szachogłuchowicz I., Wachowski M., Karpiński M., Processability of 21NiCrMo2 Steel Using the Laser Powder Bed Fusion: Selection of Process Parameters and Resulting Mechanical Properties, Materials, 15/24, 2022, pp. 1-15, 140 pkt. doi: 10.3390/ma15248972,
17. Mazurkiewicz M., Kluczyński J., Jasik K., Sarzyński B., Szachogłuchowicz I., Łuszczek J., Torzewski J., Śnieżek L., Grzelak K., Małek M., Bending Strength of Polyamide-Based Composites Obtained during the Fused Filament Fabrication (FFF) Process, Materials, 15/14, 2022, pp. 1-13, 140 pkt., doi: 10.3390/ma15145079,
18. Kluczyński J., Szachogłuchowicz I., Torzewski J., Śnieżek L., Grzelak K., Budzik G., Przeszłowski Ł., Małek M., Łuszczek J., Fatigue and fracture of additively manufactured polyethylene terephthalate glycol and acrylonitrile butadiene styrene polymers, International Journal of Fatigue, 165, 2022, pp. 1-10, 140 pkt., doi: 10.1016/j.ijfatigue.2022.107212,
19. Kosturek R., Śnieżek L., Torzewski J., Wachowski M.: Low Cycle Fatigue Properties of Sc-Modified AA2519-T62 Extrusion, Materials, 13, 220, 2020, 140 pkt., https://doi.org/10.3390/ma13010220,
20. Śnieżek L., Kosturek R., Wachowski M., Kania B.: Microstructure and residual stresses of AA2519 friction stir welded joints under different heat treatment conditions, Materials, 13, 834, 2020, 140 pkt., https://doi.org/10.3390/ma13040834,
21. Wachowski M., Kosturek R., Śnieżek L., Mróz S., Stefanik A., Szota P.: The Effect of Post-Weld Hot-Rolling on the Properties of Explosively Welded Mg/Al/Ti Multilayer Composite, Materials, 13, 1930, 2020, 140 pkt., https://doi.org/10.3390/ma13081930,
22. Kosturek R., Śnieżek L., Torzewski J., Ślęzak T., Wachowski M., Szachogłuchowicz I.: Research on the Properties and Low Cycle Fatigue of Sc-modified AA2519-T62 FSW Joint, Materials, 13, 5226, 2020, pp. 1-18, 140 pkt., https://doi.org/10.3390/ma13225226,
23. Szachogłuchowicz I., Śnieżek L., Ślęzak T., Kluczyński J., Grzelak K., Torzewski J., Fras T.: Mechanical Properties Analysis of the AA2519-AA1050-Ti6Al4V Explosive Welded Laminate, Materials, 13, 19, 2020, 140 pkt., https://doi.org/10.3390/ma13194348,
24. Kluczyński J., Śnieżek L., Grzelak K., Oziębło A., Perkowski K., Torzewski J., Szachogłuchowicz I., Gocman K., Wachowski M., Kania B.: Comparison of Different Heat Treatment Processes of Selective Laser Melted 316L Steel Based on Analysis of Mechanical Properties, Materials, 13, 3805, 2020, 140 pkt., https://doi.org/10.3390/ma13173805,
25. Kluczyński J., Śnieżek L., Grzelak K., Torzewski J., Szachogłuchowicz I., Wachowski M., Łuszczek J.: Crack Growth Behavior of Additively Manufactured 316L Steel—Influence of Build Orientation and Heat Treatment, Materials, 13, 3259, 2020, 140 pkt., https://doi.org/10.3390/ma13153259,
26. Kluczyński J., Śnieżek L., Grzelak K., Janiszewski J., Płatek P., Torzewski J., Szachogłuchowicz I., Gocman K.: Influence of Selective Laser Melting Technological Parameters on the Mechanical Properties of Additively Manufactured Elements Using 316L Austenitic Steel, Materials, 13, 1449, 2020, 140 pkt., https://doi.org/10.3390/ma13061449,
27. Kluczyński J., Śnieżek L., Kravcov A., Grzelak K., Svoboda P., Szachogłuchowicz I., Franek O., Morozov N., Torzewski J., Kubeček P.: The Examination of Restrained Joints

Created in the Process of Multi-Material FFF Additive Manufacturing Technology, Materials, 13, 4, 90, 2020, 140 pkt., https://doi.org/10.3390/ma13040903,

28. Kluczyński J., Śnieżek L., Grzelak K., Torzewski J., Szachogłuchowicz I., Oziębło A., Perkowski K., Wachowski M., Małek M.: The Influence of Heat Treatment on Low Cycle Fatigue Properties of Selectively Laser Melted 316L Steel, Materials, 13, 5737, 2020, 140 pkt., https://doi.org/10.3390/ma13245737,
29. Kluczyński J., Śnieżek L., Grzelak K., Oziębło A., Perkowski K. Torzewski J., Szachogłuchowicz I., Gocman K. Wachowski M., Kania B.: Hot isostatic pressing influence on the mechanical properties of selectively laser-melted 316L steel, Bull. Polish Acad. Sci. Tech. Sci, 68, 1413–1424, 2020, 100 pkt., DOI: 10.24425/bpasts.2020.135396,
30. Grzelak K., Kluczyński J., Szachogłuchowicz I., Łuszczek J., Śnieżek L., Torzewski J.: Modification of structural properties using process parameters and surface treatment of monolithic and thin-walled parts obtained by selective laser melting, Materials, 13, 5662, 2020, 140 pkt., https://doi.org/10.3390/ma13245662.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Modules:
1. Fundamentals of Machine Design
2. Computer-Aided Design in the Power Industry
3. Fatigue Strength and Fracture Mechanics of Materials and Structures (Doctoral School)

Average number of hours of classes: 446

Achievements

(awards, distinctions, patents in the last 5 years)

1. Team Scientific Award of the Minister of National Defense for the achievement "Innovative Technologies for the Production of Structural Materials for Military Purposes," 2024.
2. Medal of the Problems of Development of Working Machines Conference for creative activity and invaluable contribution to the development of the conference, 2023.
3. "Golden Chalk" Award granted by students of the Faculty of Mechanical Engineering, Military University of Technology, 2021/2022.
4. "Golden Chalk" Award granted by students of the Faculty of Mechanical Engineering, Military University of Technology, 2023/2024.
5. Patent No. Pat. 245246, June 2024, Method of Joining Thermoplastic Polymer Materials.
6. Patent No. PL436962A1, July 2024, Method of Manufacturing a Form-Fit Interference Joint with Additional Reinforcements.
7. Patent pending, October 2025, Modular rotary motion conveyor.

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

1. Number of promoted doctors - 3
2. Number of reviews:
   - doctoral students - 11,
   - in habilitation proceedings - 6,
   - opinions in professorial proceedings - 2

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Professor Radosław Trębiński PhD, DSci, No ORCID 0000-0002-4659-2318

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Mechanical engineering

Area of scientific interest

Ballistics, mechanics of explosion

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Editor-in-chief of the quarterly "Problems of Mechatronics. Armaments, Aerospace, Security Engineering"

Chairman of the Scientific Committee of the Annual School of Computer Aided Design, Manufacturing and Operation

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

National Centre of Research and Development project "35 mm KDA automatic naval cannon with a fire control system installed on the ship using the ZGS-158 Integrated Tracking Head made in the naval version with a fire control station", investigator, 2021
Research grant of the Ministry of National Defense "Analysis of the possibility of using pulsed plasma sources and electric field in advanced ammunition designs", principal investigator 2021,2022
Research grant of the Ministry of National Defense "The concept of achieving the ability of firefighters to have a lethal impact on targets using thermobaric ammunition", principal investigator, 2022,2023,2024
European Defence Agency research project "RECBALL", investigator, 2024,2025

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Total number of scientific articles 113, 2 monographs, 19 publications in the Web of Science database, index h=6, 37 publications in the Scopus database, index h=9

1. R. Trebinski, Z. Leciejewski, J. Kijewski, D. Gozdzik, D. Szupienko, Investigations on influence of rifle automatics system action on values of energetic efficiency coefficient of muzzle brakes, Defence Technology, 18, 10, 2022, 1741-1747, doi.org/10.1016/j.dt.2021.06.003.
2. R. Trębiński , R. Woźniak, D. Szupieńko, B. Fikus, Estimation of Ignition Pressure in Ammunition, Energies 2022, 15, 5916, doi.org/10.3390/en15165916.
3. R. Trębiński , R. Woźniak, D. Szupieńko, B. Fikus, Estimation of Priming Mixture Force, Energies 2022, 15, 5952, doi.org/10.3390/en15165952.

4. Leciejewski, Z.; Surma, Z.;Trebinski, R. Influence of the Ignition Method on the Characteristics of Propellant Burning in the Context of the Geometric Burning Model. Energies 2023, 16, 3863, doi.org/10.3390/en16093863.
5. R. Trebinski, D. Szupienko and B. Fikus, Analysis of 0D Interior Ballistics Model with Experimental Form Function Applied, Proceedings of the 33rd International Symposium on Ballistics, Bruges, Belgium, October 16–20, 2023, Vol.1, 1299-1309.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Technical mechanics
Explosive Methods in Materials Engineering
Design of experiment (in Polish SDR)
Design of experiment (in English SDR)
Introduction to Mathematical Physics Equations (SDR)
Average number of hours of classes in the last 5 years: 240

Achievements
(awards, distinctions, patents in the last 5 years)

1. Award of the Rector of the Military University of Technology for lifetime achievements, 2021
2. Team Award of the Rector of the Military University of Technology for "Maximally evaluated results of the completed research grant the concept of achieving the ability of WRiA firefighters to have a lethal impact on targets with the use of thermobaric ammunition – in line with the priority research directions for the Ministry of National Defence", 2024

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of PhDs promoted: 7

In the last 5 years, I have not reviewed doctoral dissertations and in habilitation proceedings and opinions in professorial proceedings

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Professor Jerzy Choma, 0000-0003-0582-7608

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Chemical sciences

Area of scientific interest

Prof. J. Choma research interests include: theoretical description of adsorption of single gases on micro and mesoporous adsorbents, experimental characterization of adsorption equilibria at the solid-gas and solid-liquid interfaces, preparation and modification of impregnated activated carbons, preparation and adsorption characterization of structural and surface properties of nanoporous ordered silica adsorbents (MCM-41, MCM-48, SBA-15), preparation and characterization of adsorption properties of ordered mesoporous carbon materials using "hard" and "soft" matrices. He also specializes in obtaining and characterizing the physicochemical properties of core-shell nanostructures, which consist of a carbon or silica core and a gold or silver shell. Recently, his research group has been involved in the studies of adsorption of CO_2, CH_4, H_2, and C_6H_6 on various nanoporous materials, including carbons, metal-organic frameworks, and composite nanostructured materials. Recently, a mechano-chemical method has been used to obtain these materials with very good structural parameters.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Director of the Institute of Chemistry, Military University of Technology, 2012-2024.

Member of the Board of Curators of Division III of Natural Sciences and Earth Sciences, Polish Academy of Sciences, 2019-2022.

Committee of Distinctions and Medals, Polish Chemical Society, 2025-2028.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

Principal investigator of the research project "Preparation and study of the adsorption properties of MOF-graphene hybrid materials," funded by the National Science Centre (2017-2020).
Researcher of the research project "Creating graphene-based nanostructures via sustainable mechanochemistry for adsorption removal of volatile organic compounds" funded by the National Science Centre (2025-2028).

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Information according to Scopus:
Number of publications: 167, Number of citations (exclude self-citations): 4,081, Hirsch index: 37
Top five publications from the last 5 years:

1) S. Głowniak, B. Szczęśniak, J. Choma, M. Jaroniec: „Mechanochemistry: toward green synthesis of metal-organic frameworks”,

Materials Today, 2021, 46, 109-124, https://doi.org/10.1016/j.mattod.2021.01.008.

2) S. Głowniak, B. Szczęśniak, J. Choma, M. Jaroniec: „Advances in microwave synthesis of nanoporous materials”, Advanced Materials, 2021, 2103477, doi.org/10.1002/adma.202103477.
3) J. Choma, J. Jagiełło, M. Jaroniec: „Assessing the contribution of micropores and mesopores from nitrogen adsorption on nanoporous carbons: Application to pore size analysis”, Carbon, 2021, 183, 150-157, doi.org/10.1016/j.carbon.2021.07.020.
4) K. Jaroszewska, B. Szczęśniak, B. Szyja, J. Choma, M. Jaroniec: „Inorganic mesoporous oxides: From research to industrial applications”, Materials Today, 2024, 72, 255-281, doi.org/10.1016/j.mattod.2023.11.017.
5) B. Szczęśniak, J. Choma, M. Jaroniec: „Sustainable mechanochemical synthesis of catalytically graphitized mesoporous carbons”, Microporous and Mesoporous Materials, 2024, 372, 113117, https://doi.org/10.1016/j.micromeso.2024.113117.

Education activities
(modules, average number of hours of classes, in the last 5 years)

1) Modern nanoporous materials (WAT Doctoral School)
2) Chemical technology (lecture, seminar, and tutorials)
3) Nanoporous materials (lecture and tutorials)
4) Diploma seminar

On average, approximately 150 hours were performed per year.

Achievements
(awards, distinctions, patents in the last 5 years)

Award of the Ministry of National Defence of Poland for research achievements - 2022.

Award of the Rector of the Military University of Technology for scientific achievements – 2021.

Experience as a supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Number of PhDs awarded: 12

Number of reviews (in the last 5 years) of doctoral dissertations: 3

Participation in habilitation proceedings (in the last 5 years): 8

Opinions in professorial proceedings (in the last 5 years): 2

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Prof. dr hab. inż. Stanisław Cudziło, 0000-0002-0300-4344

Position, management function

Research and teaching professor

Scientific discipline represented (scientific disciplines %)

Chemical sciences

Area of scientific interest

Prof. Stanisław Cudziło's research focuses on the chemistry and technology of explosives, gun and rocket propellants, and pyrotechnic mixtures, as well as the use of combustion and detonation processes in materials science (*exact and natural sciences / chemical sciences and technical sciences / materials engineering*). He specializes in experimental methods for testing explosives, researching the interaction of detonation and shock waves with various media, and studying chemical reactions in detonation and combustion waves, including chemical and physical analyses of the products of these reactions. In parallel with his research on the combustion synthesis of nanostructured carbon and ceramic materials, he conducts research aimed at designing the structure, synthesizing, and testing the properties of explosive compounds and mixtures characterized by high detonation parameters and reduced sensitivity to mechanical and thermal stimuli.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Until 2020, Prof. Stanisław Cudziło served as Dean of the Faculty of Advanced Technologies and Chemistry and was a member of the Senate of the Military University of Technology. Since 2020, Prof. Cudziło has been a member of the Discipline Council for Chemical Sciences, where he serves as Chair of the Science Committee.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

From 2017 to 2023, Prof. Cudziło led the implementation of a high-budget research project at the Military University of Technology entitled "*Development and Construction of Demonstrators of Critical Elements for the New Generation of 120 mm Tank Ammunition*" financed by the National Centre for Research and Development under contract no. DOB-BIO8/05/01/2016. The project resulted in the development, for the first time in Poland, of qualitative and quantitative compositions and examination of the properties of low vulnerability gun propellants (LOVA type), as well as the development of the technology for producing propellant grains from these materials in industrial installations (technology readiness level VI was achieved). From 2023 to 2025, Prof. Cudziło led the implementation of four research and development projects financed by Polish defense companies (MESKO S.A. and NITROCHEM S.A.). This work aimed to confirm the suitability of domestic raw materials for use in LOVA propellants and to scale up their production, i.e., achieve IX TRL. Concurrently, at the commission of NITROCHEM S.A., a team led by Prof. Cudziło conducted two research and development projects, resulting in the development of a universal thermobaric explosive (UTBX) and the design of

a grenade containing it (RG-NW). These products were awarded the second prize in the 11th National State Security Leader Competition 2023. Currently (from July 1, 2022, to June 30, 2026), Prof. Cudziło is also managing the project entitled "*Energetic Materials – Production, Obsolescence, and Formulation (EMPOF)*," which is funded by the European Defence Agency (EDA) under contract no. B.PRJ.RT.957. The main goal of the EMPOF project is to select non-toxic, critical components of explosives and to make European producers independent of suppliers from countries subject to restrictions, as well as to develop new, more ecological methods of producing explosives using new components.

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

According to the ISI Web of Science database, the current scientometric parameters of Prof. Cudziło are as follows: H-index = 21, number of papers registered in the database = 93, number of citations = 1426, without self-citations = 1319. In the last 5 years, the following publications co-authored by Prof. Cudziło have been published:

1. Ł. Gutowski, S. Cudziło, *Synthesis and Properties of Novel Nitro-based Thermally Stable Energetic Compounds*, Defence Technology, **17**, 775-784, 2021.
2. M. Gratzke, S. Cudziło, *Energetic Derivatives of Nitroguanidine – Synthesis and Properties*, Propellants, Explosives, Pyrotechnics, **46**, 1509-1525, 2021.
3. K. S. Carney; P. DuBois; S. Cudziło; G. A. Jorgensen, W. Bienienda, *The Effect of TNT Mass and Standoff Distance on the Response of Fully Clamped Circular Aluminum Plates to Confined Air-Blast Loading*, International Journal of Impact Engineering, 170, 104357, 2022.
4. T. M. Klapötke, S. Cudziło, W. A. Trzciński, *An Answer to the Question about the Energetic Performance of TKX-50*, Propellants, Explosives, Pyrotechnics, **47**, e202100358, 2022.
5. E-Ch. Koch, S. Cudziło, W. A. Trzciński, J. Paszula, *Combustion and Detonation Behaviour of Ammonium perchlorate / Phosphorus(V) nitride, P_3N_5*, Propellants, Explosives, Pyrotechnics, **47**, e202200007, 2022.
6. T. M. Klapötke, S. Cudziło, W. A. Trzciński, J. Paszula L. Bauer, Ch. Riedelsheimer and J. Lechner, *Performance of TKX-50 in Thermobaric Explosives*, Propellants, Explosives, Pyrotechnics, **48**, e202300010, 2023.
7. E-Ch. Koch, S. Cudziło, W. A. Trzciński, J. Paszula, *Detonation of High Explosives containing Phosphorus(V) nitride, P_3N_5*, Propellants, Explosives, Pyrotechnics, **48,** e202300039, 2023.
8. D. Kozień, P. Żeliszewska, B. Szermer-Olearnik, Z. Adamczyk, A. Wróblewska, A. Szczygieł, K. Węgierek-Ciura, J. Mierzejewska, E. Pajtasz-Piasecka, T. Tokarski, G. Cios, S. Cudziło, Z. Pędzich, *Synthesis and characterization of boron carbide nanoparticles as potential boron-rich therapeutic carriers*, Materials, **16**(19), 6534, 2023.
9. T. M. Klapötke, S. Cudziło, W. A. Trzciński, J. Paszula, *Energy and blast performance of beryllium in a model thermobaric composition in comparison with aluminum and magnesium*, Defence Technology, **36**, 13-19, 2024.
10. S. Cudziło, B. Szermer-Olearnik; S. Dyjak, M. Gratzke, K. Sobczak, A. Wróblewska, A. Szczygieł, J. Mierzejewska, K. Węgierek-Ciura, A. Rapak, P. Żeliszewska, D. Kozień, Z. Pędzich, E. Pajtasz-Piasecka, *Combustion Synthesis of Functionalized Carbonated Boron Nitride Nanoparticles and their Potential Application in Boron Neutron Capture Therapy*, Materials, **17**(10), 2438, 2024.

11. T. M. Klapötke, S. Cudziło, W. A. Trzciński, J. Paszula, *Beryllium and Cerium Powders as Potential Activators of Aluminum in TBX Compositions*, Propellants, Explosives, Pyrotechnics, **50**, e202400338, 2025.
12. D. Kozień, W. Banas, S. Cudziło, A. Grabos, K. Pasiut, W. Pyda, A. Wojteczko, M. Grabowy, Z. Pędzich, *Behaviour of reactively sintered TiB_2-SiC composites under sudden impact*, Processing and Application of Ceramics, **19**(1), 43-50, 2025.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Professor Stanisław Cudziło consistently exceeds his teaching load, performing 170-200 lecture hours per year in recent years. He lectures on the following subjects: *High-Energetic Materials*, *Chemistry and Technology of Explosives*, *New Generation Explosives*, *Rocket Propellants*, and *Advanced High-Energetic Materials*. These courses are included in the curricula of students at the Faculty of Advanced Technologies and Chemistry and the Faculty of Mechatronics, Armaments, and Aeronautics. At the Military University of Technology Doctoral School, Prof. Cudziło teaches a course titled *Chemistry and Technology of High-Energetic Materials*. To date, this course has been chosen by doctoral students three times.

Achievements
(awards, distinctions, patents in the last 5 years)

Second-degree award in the 11th National State Security Leader Competition 2023 for the development of a universal, thermobaric explosive.

Experience in supervising and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Over the last five years, Professor Cudziło has supervised three doctoral dissertations that were successfully defended, reviewed one PhD dissertation, four habilitation dissertations, and wrote one opinion in a professorial procedure.

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

PhD, DSc. Eng. Przemysław Kula, 0000-0002-7862-7968

Position, management function

Head of Chair on Chemistry

Scientific discipline represented (scientific disciplines %)

Chemical Sciences 100%

Area of scientific interest

Organic Chemistry, Novel Functional Materials, Liquid Crystals

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Chair of Scientific Committees of several CLC, ILCC, and OLC conferences

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

Principial Investigator of several NCN Projects, UE Projects, Projects with companies and foreign Universities:
Projekt UE FETOPEN Topolight 964770 2021-2025 – PI of the group
Projekt OPUS NCN 2024/53/B/ST5/03275 2025-2029 – PI
Projekt OPUS NCN 2024/55/B/ST5/015862025-2028 – PI of the group
Projekt zamawiany UPM Hiszpania – PI

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

179 publications, h-index 29

1. Gorecka, E.; Majewska, M.; Fekete, L.; Karcz, J.; Zukowska, J.; Herman, J.; Kula, P.; Pociecha, D., Spontaneous helix formation in a polar smectic phase. *MATERIALS HORIZONS* **2025,** *12* (14), 5352-5356.
2. Karcz, J.; Herman, J.; Rychlowicz, N.; Kula, P.; Górecka, E.; Szydlowska, J.; Majewski, P. W.; Pociecha, D., Spontaneous chiral symmetry breaking in polar fluid-heliconical ferroelectric nematic phase. *SCIENCE* **2024,** *384* (6700), 1096-1099.
3. Karcz, J.; Rychlowicz, N.; Czarnecka, M.; Kocot, A.; Herman, J.; Kula, P., Enantiotropic ferroelectric nematic phase in a single compound. *CHEMICAL COMMUNICATIONS* **2023,** *59* (100), 14807-14810.
4. Król, M.; Sigurdsson, H.; Rechcinska, K.; Oliwa, P.; Tyszka, K.; Bardyszewski, W.; Opala, A.; Matuszewski, M.; Morawiak, P.; Mazur, R.; Piecek, W.; Kula, P.; Lagoudakis, P. G.; Pietka, B.; Szczytko, J., Observation of second-order meron polarization textures in optical microcavities. *OPTICA* **2021,** *8* (2), 255-261.
5. Lekenta, K.; Król, M.; Mirek, R.; Lempicka, K.; Stephan, D.; Mazur, R.; Morawiak, P.; Kula, P.; Piecek, W.; Lagoudakis, P. G.; Pietka, B.; Szczytko, J., Tunable optical spin Hall effect in a liquid crystal microcavity. *LIGHT-SCIENCE & APPLICATIONS* **2018,** *7*.
6. Lempicka-Mirek, K.; Krol, M.; Sigurdsson, H.; Wincukiewicz, A.; Morawiak, P.; Mazur, R.; Muszynski, M.; Piecek, W.; Kula, P.; Stefaniuk, T.; Kaminska, M.; De Marco, L.; Lagoudakis, P. G.; Ballarini, D.; Sanvitto, D.; Szczytko, J.; Pietka, B., Electrically tunable Berry

curvature and strong light-matter coupling in liquid crystal microcavities with 2D perovskite. *SCIENCE ADVANCES* **2022,** *8* (40).

7. Nys, I.; Liu, S. Q.; Huang, Y. N.; Strzezysz, O.; Kula, P.; Neyts, K., Geometric Phase Flat Optical Gratings with High Diffraction Angle Based on Dual-Frequency Nematic Liquid Crystal. *ADVANCED OPTICAL MATERIALS* **2023,** *11* (23).

8. Parisi, E.; Santagata, E.; Kula, P.; Herman, J.; Gupta, S.; Simone, E.; Zarrella, S.; Korter, T. M.; Centore, R., Mechanical Transitions in Crystals: The Low-Temperature Thermosalient Transition of a Mesogenic Polyphenyl. *JOURNAL OF THE AMERICAN CHEMICAL SOCIETY* **2025,** *147* (17), 14731-14738.

9. Rechcinska, K.; Król, M.; Mazur, R.; Morawiak, P.; Mirek, R.; Lempicka, K.; Bardyszewski, W.; Matuszewski, M.; Kula, P.; Piecek, W.; Lagoudakis, P. G.; Pietka, B.; Szczytko, J., Engineering spin-orbit synthetic Hamiltonians in liquid-crystal optical cavities. *SCIENCE* **2019,** *366* (6466), 727-+.

10. Szukalska, A. B.; Karcz, J.; Herman, J.; Pociecha, D.; Górecka, E.; Kula, P.; Mysliwiec, J., Temperature-Tunable Heliconical and Ferroelectric Nematics for White Lasing. *ADVANCED MATERIALS* **2025**.

11. Talwar, M.; Perera, K.; Mostafa, M.; Gill, M.; Nepal, P.; Guragain, P.; Landau, I.; Kula, P.; Twieg, R.; West, J. L.; Jákli, A., Optically Isotropic Polymer Stabilized Liquid Crystals with Fast and Large Field-Induced Refractive Index Variation. *ADVANCED OPTICAL MATERIALS* **2024,** *12* (34).

Education activities

(modules, average number of hours of classes, in the last 5 years)

Organic Chemistry
Synthesis of Liquid Crystals
Mass Spectrometry
Average number of hours 300 h/Y

Achievements

(awards, distinctions, patents in the last 5 years)

Medal KEN 2025

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

7 promoted PhD students, in the last 5 years:

1. Marta Pytlarczyk – promotor – „Synteza i badanie nematycznych materiałów ciekłokrystalicznych o zwiększonej fotochemicznej stabilności w zakresie promieniowania UVA-VIS” - nadanie stopnia doktora 16.03.2021
2. Ewelina Dmochowska – promotor, „Synteza i badanie właściwości chiralnych reaktywnych mezogenów oraz bimezogenów o uporządkowaniu antyklinicznym”, Nadanie stopnia doktora - chemia 28.11.2022
3. Sayani DAS – co-promotor, , Shiv Nadar University, Delhi NCR, Indie, OCT.2025

Numer of scientific reviews 30/Y, number of habilitation reviews 3.

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID

D.Sc. (Eng.) Stanisław Popiel, ORCID: 0000-0001-5557-5061

Position, management function

Associate professor

Scientific discipline represented (scientific disciplines %)

Chemical Sciences (100%)

Area of scientific interest

1. Chemistry and physicochemical properties of chemical warfare agents (CWAs), in particular: the chemical and physicochemical basis of CWA decontamination; development of new methods for CWA neutralization.
2. Chromatographic analysis, particularly the analysis of CWAs and their degradation products; development of new materials to serve as stationary phases for solid-phase microextraction (SPME).
3. Microscale synthesis, purification, and identification of compounds that may form during CWA degradation in the environment and during decontamination processes.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Membership in the Polish Chemical Society

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

European Union project (Interreg Baltic Sea Region Programme 2021–2027).
Project title: “Action Plan for the Remediation of Munitions in the Baltic Sea” (Baltic Sea Munition Remediation Roadmap – MUNIMAP).
Project start date: 1 March 2024
Project end date: 28 February 2027

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Publications from the last 5 years (2021–2025):

1. Wojciech Wilczyński, Tomasz Brzeziński, Jakub Nawała, Daniel Dziedzic, Stanisław Popiel, Marcin Żebrowski, Michał Czub, Jacek Bełdowski, and Monika Radlińska. “Chronic Toxicity of Triphenylarsine to Danio rerio.” Ecotoxicology and Environmental Safety 299 (2025) 118366.
   DOI: 10.1016/j.ecoenv.2025.118366. **IF = 6,1**
2. Maciej Boczkowski, Stanisław Popiel, Jakub Nawała, and Hubert Suska. “History of Organophosphorus Compounds in the Context of Their Use as Chemical Warfare Agents.” Molecules 30 (2025) 1615. DOI: 10.3390/molecules30071615. **IF = 4,6**
3. Klaudia Kozon, Jakub Nawała, Paweł Sura, and Stanisław Popiel. “Study on the Reaction Kinetics of Sulfur Mustard, Nitrogen Mustard and Their Chosen Analogues with Sodium Ethoxide.” Molecules 30 (2025) 780.
   DOI: 10.3390/molecules30040780. **IF = 4,6.**

4. Jakub Woźniak, Jakub Nawała, Daniel Dziedzic, and Stanisław Popiel. “Overview of Liquid Sample Preparation Techniques for Analysis, Using Metal-Organic Frameworks as Sorbents.” Molecules 29 (2024) 4752. DOI: 10.3390/molecules29194752. **IF = 4,6.**
5. Jakub Woźniak, Stanisław Popiel, Jakub Nawała, Barbara Szczęśniak, Jerzy Choma, and Dariusz Zasada. “Novel Application of Metal–Organic Frameworks as Efficient Sorbents for Solid-Phase Extraction of Chemical Warfare Agents and Related Compounds in Water Samples.” Molecules 29 (2024) 3259. DOI: 10.3390/molecules29143259. **IF = 4,6.**
6. Wojciech Wilczyński, Monika Radlińska, Marcin Łukasz Żebrowski, Jakub Nawała, Daniel Dziedzic, Michał Czub, Piotr Maszczyk, Jacek Bełdowski, Stanisław Popiel, and Tomasz Brzeziński. “Multi-Biomarker Assessment of Chronic Toxicity Induced by the Chemical Warfare Agent Adamsite in Danio rerio.” Chemosphere, 366 (2024) 143478. DOI: 10.1016/j.chemosphere.2024.143478. **IF = 8,1.**
7. Maciej Boczkowski, Stanisław Popiel, and Jakub Nawała. “Application of Chemical Ionization in the Analysis of Ethylphosphonic Acid Derivatives.” Journal of the American Society for Mass Spectrometry 35 (2024) 714–727. **IF = 2,7.** DOI: 10.1021/jasms.3c00392.
8. Patrik Fauser, Michał Czub, Jacek Bełdowski, Hanna Niemikoski, Paula Vanninen, Stanisław Popiel, Jakub Nawała, Daniel Dziedzic, and Hans Sanderson. “Chemical Warfare Agents and Their Risk Assessment in Daphnia magna and Fish in the Baltic Sea—15 Years of Measurements.” Journal of Hazardous Materials Advances 12 (2023) 100386. DOI: 10.1016/j.hazadv.2023.100386. **IF = 5,5.**
9. Barbara Szczęśniak, Sylwia Głowniak, Jakub Woźniak, Stanisław Popiel, Jerzy Choma, and Mietek Jaroniec. “Ordered Mesoporous Carbons with Well-Dispersed Nickel or Platinum Nanoparticles for Room Temperature Hydrogen Adsorption.” Molecules 28 (2023) 6551. DOI: 10.3390/molecules28186551. **IF = 4,2.**
10. Wojciech Wilczyński, Tomasz Brzeziński, Piotr Maszczyk, Antoni Ludew, Michał J. Czub, Daniel Dziedzic, Jakub Nawała, Stanisław Popiel, Jacek Beldowski, and Hans Sanderson. “Acute Toxicity of Organoarsenic Chemical Warfare Agents to Danio rerio Embryos.” Ecotoxicology and Environmental Safety 262 (2023) 115116. DOI: 10.1016/j.ecoenv.2023.115116. **IF = 6,2.**
11. Paweł Sura, Damian Stępień, Jakub Nawała, Daniel Dziedzic, Mateusz Szala, and Stanisław Popiel. “The Bromine Analog of Sulfur Mustard: Synthesis and Reactivity Studies.” Journal of Molecular Structure 1286 (2023) 135510. DOI: 10.1016/j.molstruc.2023.135510. **IF = 4,0.**
12. Tobias Klöffel, Diana Gordon, Stanisław Popiel, Jakub Nawała, Bernd Meyer, and Paweł Rodziewicz. “Understanding the Mechanism of the Sulfur Mustard Hydrolysis Reaction on the Atomistic Level from Experiment and First-Principles Simulations.” Process Safety and Environmental Protection 172 (2023) 105–112. DOI: 10.1016/j.psep.2023.02.001. **IF = 6,9.**
13. Daniel Dziedzic, Jakub Nawała, Diana Gordon, Barbara Dawidziuk, and Stanisław Popiel. “Nanostructured Polyaniline SPME Fiber Coating for Chemical Warfare Agents Analysis.” Analytica Chimica Acta 1202 (2022) 339649. DOI: 10.1016/j.aca.2022.339649. **IF = 6,2.**
14. Katarzyna Lech, Jakub Nawała, and Stanisław Popiel. “Mass Spectrometry for Investigation of Natural Dyes in Historical Textiles: Unveiling the Mystery behind

Safflower-Dyed Fibers." Journal of the American Society for Mass Spectrometry, 32, (2021) 2552–2566. DOI: 10.1021/jasms.1c00195. **IF = 3,3.**

15. Jakub Nawała, Diana Gordon, Daniel Dziedzic, Paweł Rodziewicz, and Stanisław Popiel. "Why Does Clark I Remain in the Marine Environment for a Long Time?" Science of the Total Environment 774 (2021) 145675. DOI: 10.1016/j.scitotenv.2021.145675. **IF = 10,6.**
16. Tobias Klöffel, Mariana Kozłowska, Stanisław Popiel, Bernd Meyer, and Paweł Rodziewicz. "Adsorption of Sulfur Mustard on Clean and Water-Saturated ZnO(10=1¯0): Structural Diversity from First-Principles Calculations." Journal of Hazardous Materials 402 (2021) 123503. DOI: 10.1016/j.jhazmat.2020.123503. **IF = 14,2.**
17. Mariusz Kluska, Joanna Jabłońska, Wiesław Prukała, and Stanisław Popiel. "Research on the Stability of Biologically Active (E)-Azastilbene Derivatives in Polish Rivers." Polish Journal of Environmental Studies 30 (2021) 1647–1653. DOI: 10.15244/pjoes/126000. **IF = 1,9.**
18. Michał Czub, Jakub Nawała, Stanisław Popiel, Tomasz Brzeziński, Piotr Maszczyk, Hans Sanderson, Edmund Maser, Diana Gordon, Daniel Dziedzic, and Barbara Dawidziuk. "Acute Aquatic Toxicity of Arsenic-Based Chemical Warfare Agents to Daphnia magna." Aquatic Toxicology 230 (2021): 105693. DOI: 10.1016/j.aquatox.2020.105693. **IF = 5,2.**

Education activities
(modules, average number of hours of classes, in the last 5 years)

1. Contemporary Methods in Analytical Chemistry — first-cycle studies, WTC
2. Chemistry of Toxic Agents and Decontamination Processes — first-cycle studies, WTC
3. Sample Preparation Methods for Analysis — SDR
4. Analysis of Chemical Warfare Agents — SDR

Average number of teaching hours over the last five years: 242

Achievements
(awards, distinctions, patents in the last 5 years)

—

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

1. Barbara Dawidziuk, Development of analytical methods for explosives and their transformation products in the bottom sediments of the Baltic Sea, WAT (Military University of Technology), 2020. PhD (Doctoral dissertation).
2. Diana Gordon, Study of the transformations of chemical warfare agents and explosives in the Baltic Sea environment, WAT (Military University of Technology), 2020. PhD (Doctoral dissertation).

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Scientific Business Card

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PhD Jarosław Puton, 0000-0003-4110-0377

Position, management function

Associate professor, Military University of Technology (MUT)

Scientific discipline represented (scientific disciplines %)

Chemistry, 100 %

Area of scientific interest

Instrumental analysis, analytical chemistry, gas ionization processes

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

- Secretary of the MUT's Library Council
- Secretary of the Science Committee at the Scientific Discipline Council for Chemical Sciences

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

Project DOB-SZAFIR/09/A/010/01/2021, 2021-06-01 – 2025-05-31, National Center for Research and Development

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Number of publications: 34 (Web of Science), 32 (Scopus)
Hirsh index: 13 (Web of Science, Scopus)
Most important publications:

1. E. Budzyńska, S. Sielemann, J. Puton, A.L.R.M. Surminski, Analysis of e-liquids for electronic cigarettes using GC-IMS/MS with headspace sampling, Talanta, 209 (2020) 120594.
2. M. Wiśnik-Sawka, E. Budzyńska, J. Puton, Application of Ion Mobility Spectrometry for Permeability Studies of Organic Substances through Polymeric Materials, Molecules 25 (2020) 2983.
3. Wolańska, I.; Budzyńska, E.; Puton, J. Studies on the Processes of Electron Capture and Clustering of Benzyl Chloride by Ion Mobility Spectrometry. Molecules 2021, 26, 4562.
4. E. Budzyńska, I. Wolańska, J. Puton, Negative-mode ion mobility spectrometry—comparison of ion–molecule reactions and electron capture processes, Anal. Bioanal. Chem. 414 (2022) 3719-3728.
5. I. Wolańska, K. Piwowarski, E. Budzyńska, J. Puton, Effect of Humidity on the Mobilities of Small Ions in Ion Mobility Spectrometry, Anal. Chem. 2023, 95, 22, 8505–8511.
6. I. Wolańska, K. Piwowarski, J. Puton, Conservation of the Charge in Signal from Drift Tube Ion Mobility Spectrometers, Anal. Chem., Anal. Chem. 2024, 96, 17337−17344.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Courses taught:

1. Nuclear Physics, Engineer’s and Master's degree programs, Faculty of New Technologies and Chemistry
2. Fundamentals of Nuclear Energetics, Master's degree program, Faculty of Electronics
3. Chemical and Radiometric Measurements, Master's degree program, Faculty of Electronics
4. Ionization Methods in Analytics, Doctoral School, Military University of Technology

Average number of class hours per year: 190

Achievements
(awards, distinctions, patents in the last 5 years)

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

- 3 PhDs promoted
- 2 PhD thesis reviews
- 1 habilitation review

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Scientific Business Card

Title/degree Name and Surname, No ORCID

Prof. dr hab. eng. Marzena Tykarska, 0000-0002-1409-8374

Position, management function

Professor, Director of the Institute of Chemistry

Scientific discipline represented (scientific disciplines %)

Chemical Sciences (100%)

Area of scientific interest

The scientific activity of prof. Marzena Tykarska is devoted to the physical chemistry of liquid crystals. She conducts research on phase transitions in these materials, particularly thermal analysis and phase identification. She also characterizes organic compounds using UV-Visible and vibrational IR electron spectroscopy. She uses these methods to study molecular ordering. She designs liquid crystal mixtures with potential application properties. She is particularly interested in non-additive phenomena occurring in liquid crystal mixtures, such as enhancement, destabilization, and induction. For example, she has described the phenomenon of induction of the antiferroelectric phase in mixtures of compounds that do not form this phase. She has explained the phenomenon of the inversion of macroscopic helicoidal structures upon temperature in chiral tilted phases (ferroelectric and antiferroelectric) using UV-Visible, IR, NMR, and CD spectroscopic methods.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

- Director of the Institute of Chemistry WTC WAT 2024-2028
- Deputy Chairman of the Senate Committee for Students and PhD Students 2020-2024,
- Deputy Chairman of the Scientific Discipline of Chemical Sciences 2020-2024, 2024-2028,
- President of the Polish Liquid Crystal Society 2021-2024, 2025-2028

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Number of publications **115**, according to: Scopus **98**, Web of Science **85**
Hirsch Index according to: Scopus **25**, Web of Science **24**

The most important publications in the last 5 years:

1. A. Deptuch, A. Drzewicz, M. Dziurka, N. Górska, J. Hooper, T. Jaworska-Gołąb, E. Juszyńska-Gałązka, M. Marzec, M. Piwowarczyk, M. Srebro-Hooper, M. Tykarska, M. Urbańska, Influence of fluorosubstitution on physical properties of the smectogenic chiral ester, Materials Research Bulletin, 150, 111756-11 (2022), DOI: 10.1016/j.materresbull.2022.111756
2. M. Tykarska, K. Kurp, P. Zieja, J. Herman, S. Stulov, A. Bubnov, New quaterphenyls laterally substituted by methyl group and their influence on the

self-assembling behaviour of ferroelectric bicomponent mixtures, Liq. Cryst. 49(6), 821-835 (2022), DOI: 10.1080/02678292.2021.2014998

3. P. Zieja, M. Tykarska, P. Morawiak, W. Piecek, Influence of the molecular structure of calamitic compounds with trifluoromethoxy terminal group on the induction of the smectic A phase. Part I, Liq. Cryst. 50(3), 363-378 (2023), DOI: 10.1080/02678292.2022.2127160
4. A. Deptuch, T. Jaworska-Gołąb, M. Dziurka, J. Hooper, M. Srebro-Hooper, M. Urbańska, M. Tykarska, M. Marzec, Determination of tilt angle and its behavior in chiral smectic phases by exploring molecular conformations using complementary methods, Phys. Rev. E, 107(3), 034703 (2023), DOI:10.1103/PhysRevE.107.034703
5. P. Zieja, M. Tykarska, P. Morawiak, P. Perkowski, W. Piecek, Influence of the molecular structure of compounds with terminal isothiocyanate group on the induction of the smectic A phase. Part II, Liq Cryst., 50(13-14), 2186-2203 (2023), DOI: 10.1080/02678292.2023.2238655
6. M. Tykarska, P. Zieja, Influence of the molecular structure of compounds differing with terminal polar group on the induction of the smectic A phase. Part III, Liq Cryst., 51(2), 305-317 (2024), DOI: 10.1080/02678292.2023.2297401
7. M. Tykarska, K. Kurp, S. Mironov, N. Rychłowicz, J. Karcz, J. Dziaduszek, P. Kula, S. Stulov, A. Bubnov, Tuning of self-organizing and electro-optical behaviour for orthoconic ferroelectric liquid crystal by non-chiral dopants, J. Mol. Liq., 125426 (2024), DOI: 10.1016/j.molliq.2024.125426
8. M. Tykarska, B. Klucznik, J. Dziaduszek, S. Jóźwiak, Miscibility Studies of Bismesogen CBnCB Forming Nematic Twist-Bend Phase with Cyanobiphenyls nCB, Materials, 17(17), 4256 (2024), DOI: 10.3390/ma17174256
9. A. Drzewicz, M. Rossi, M. Cifelli, G. Saielli, M. Tykarska, V. Domenici, Chemical and physical properties of orthoconic liquid crystals: 2H NMR spectroscopy and Molecular Dynamics simulations, Soft Matter, 21, 1646-1661 (2025), DOI: 10.1039/d4sm01321b

Education activities

(modules, average number of hours of classes, in the last 5 years)

- Chemical material science (lectures),
- Spectroscopy (lectures and exercises),
- Spectroscopic methods (lectures, Doctoral School of WAT),
- Wstęp do metod spektroskopowych (lectures, Doctoral School of WAT),
- Polymer materials (lectures in English, Erasmus)

average number of teaching hours: 180/year

Achievements

(awards, distinctions, patents in the last 5 years)

2021 - Silver Cross of Merit

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

number of promoted doctors: 4

number of doctoral student reviews (in the last 5 years): 1

Contact

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Scientific Business Card

Title/degree Name and Surname, No ORCID
Prof. Marian Cieślarczyk, PhD, DSc, ORCID 0000 0002 3382 8168
Position, management function
Professor
Scientific discipline represented (scientific disciplines %)
Security Sciences 100%
Area of scientific interest
Security and defense systems, security culture, research methodology in the social sciences, including security sciences, societal resilience and state resilience.
Organizational activities *(participation in the work of various bodies, functions performed, in the last 5 years)*
Polish Society for Security Studies (co-founder and first chairman, currently chairman of the Security Culture Section of the Polish Society for Security Studies), Polish Sociological Society (member), Drohiczyn Scientific Society (member)
Research activities *(participation in programs, projects, grants, method of financing, in the last 5 years)*
UGB WAT on: Students' Pro-Defense Attitudes towards the Challenges and Threats of the Third Decade of the 21st Century, 2020 – Project Manager UGB WAT on: Civil Protection and Civil Defense in the Security and Defense System of the Republic of Poland, 2025 – Project Manager
Publishing activities *(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)*
The most important publications during this time include: - Cieślarczyk M., "Challenges for safety sciences and education in the light of the current experience with the Covid-19 pandemic," Defence Science Review, Volume 1, No. 9, 2020, Military University of Technology, Warsaw 2020 (article). - Cieślarczyk M., Filipek A., Krzewniak D., "Safety culture of academic youth in the context of sustainable development," Siedlce 2021 (monograph). - Cieślarczyk M., "The importance of safety culture in logistics processes. Based on the example of the COVID-19 pandemic and other elements of a cascading crisis situation," Warsaw 2022 (monograph). - Cieślarczyk M., "The Kremlin's Tough Influence on the Polish Decision-Making Process," in: M. Górnikiewicz, R. Bielawski (eds.), "Influense of Russian Activites," V&R Germany, 2023 (chapter in the monograph). - Cieślarczyk M., "Russian "Soft Power" Methodology in Influencing the Polish Decision-Making," in: M. Górnikiewicz, R. Bielawski (eds.), "Influense of Russian Activites," V&R Germany, 2023 (chapter in the monograph). - Cieślarczyk M.,Safety cultureduring the COVID-19 pandemic and the effective way of dealing with the coronavirus and consequences, in: N.Moch, W.S.Wereda, J.Stańczyk (eds.), Information, Security and Society in the COVID-19 Pandemic, Routledge, New York 2023 (chapter in the monograph). - Cieślarczyk M., "The Well-Being of Disposable Groups in the Light of Selected Elements of Security Science Knowledge," in: J. Gierszewski, I. Osmólska (scientific ed.), "The Well-Being of Disposable Groups. Contemporary and Historical Approaches," Słupsk 2023 (chapter in a monograph).

- Cieślarczyk M., "The Importance of Methodological Culture for the Accuracy of Situational Assessments and the Effectiveness of Coping with Contemporary Problems, Including Qualification Papers," (monograph, due for publication at WAT Publishing House – December 2025).

Education activities
(modules, average number of hours of classes, in the last 5 years)

Morale and Security Culture in National and International Relations (SDR),
State Security Culture,
Cultural Security,
Sociology of Security
Basic Research Methodology
Social Research Methodology
Crisis Management System
Crisis Logistics, Critical Infrastructure Protection
Average number of hours per academic year: 200-250 hours

Achievements
(awards, distinctions, patents in the last 5 years)

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

In the last five years:
I. I have supervised two doctoral dissertations:
1. M. Pardyak, "Faces of Terrorism and Methods of Research on Its Psychosocial and Organizational Conditioning," Military University of Technology, 2023;
2. A. Czesławiak, "Safety Culture of Students, Parents, and Teachers and the Functioning of Schools in Contemporary Civilization," AS, Siedlce, 2023.
II. I have reviewed five doctoral dissertations:
1. Szymon Noworyta, MA, on "The Impact of Voluntary, Compulsory Military Service on the Safety Culture in the Airborne Troops of the Polish Armed Forces," AB, Dąbrowa Górnicza, 2025; 2. Katarzyna Batorowska, M.A., on "The Sense of Information Security of Local Communities in the Aspect of Selected Civilizational Threats Based on the Example of the Community of Sucha Beskidzka," State University of Technology, Siedlce 2023.
3. Grzegorz Dementiew, M.A., on "The Public Security System in the Pomeranian Voivodeship in the Condition of Climate Change – Current Status and Directions of Evolution," State University of Technology, Słupsk 2022.
4. Jarosław Sikora, M.A., on "The Online Image of the Mass Migration Phenomenon and the State's Internal Security," WSPol. Szczytno, May 2021.

5. Anna Kamińska, M.A., on "Contemporary Conditions of Security in the Republic of Moldova," Military Academy of Sciences, December 2021.

III. I prepared an opinion in the professorial proceedings of Dr. Juliusz Piwowarski in the field of social sciences, in the discipline of security science, April 2025.

Contact

Place of work: building no./room no.: Location: Building No./Room No. - Classes were held in Building 135 and several other teaching buildings at the Military University of Technology.

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Email: marian.cieslarczyk@wat.edu.pl

Scientific Business Card

Title/degree Name and Surname, No ORCID

prof. dr hab. inż. Szymon MITKOW, ORCID: 0000-0003-2845-2589

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Safety sciences (100%)

Area of scientific interest

Military security, national defence, military and enterprise logistics, transport, acquisition of military equipment, the use of quantitative and qualitative methods in security and logistics, forecasting of the security environment, and the development and evaluation of military technology.

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Participation in the work of various bodies:

1. Member of *the System Analyses and Studies Panel* (SAS) *of the Science & Technology Organization* (STO) of NATO from 2005 to 2021, representative of Polish in the SAS Panel without the right to vote (*Panel member*). From 2021 to 2024, Polish representative in the *Principal Panel member*.
2. Member of the Scientific Council of the Air Force Institute of Technology in 2017-2021.
3. Member of the Scientific Council of the Air Force Institute of Technology 2022-2025.
4. Member of the Electromobility and Autonomous Transport Section of the Transport Committee of the Polish Academy of Sciences – 2020-2025.
5. Member of the Scientific Committee – "*Bellona Quarterly*" 2017 - 2025.
6. Member of the Scientific Council of the Publishing House of the Centre and Training of the Armed Forces 2020-2025.
7. Member of the Jury of the LBP State Security Leader Competition – 2021-2025.

Functions:

1. Dean of the Faculty – 2017-2024.
2. Member of the WAT Senate – 2020-2024.
3. Chairman of the Council of the Scientific Discipline of "Security Sciences" – 2018-2024 and 2024-2028.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Member of the research team of the project entitled "*The first Polish – author's method of forecasting the effectiveness of scientific and economic cooperation*" carried out as part of the research work NDS/547274/2022/2022 funded by the Ministry of Education and Science, project duration 12.08.2022 – 11.08.2024.
2. Head of the research team implementing the project PN.: 997/2018 of the Ministry of Defence entitled "*Logistics system as a determinant of the defence capabilities of the Republic of Poland*" funded under the programme (competition) RESEARCH GRANT OF THE MINISTRY OF DEFENCE 2018 – 2022 and Head of the research task carried out as part of this project in 2022

entitled "*Model of the functioning of the logistics system in the process of ensuring the defence capabilities of the Republic of Poland*".

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

The most important publications:

1. Mitkow Sz., *Military Security of Polish in the Realities of the XXI Century - Selected Aspects,* Difin, Warsaw 2023 - ISBN 978-83-8270-178-4.
2. Mitkow Sz., *Managing the process of satisfying the logistic needs of the military defense potential* [in:] Logistics Needs of the Defense Potential. ISBN 978-83-8180-386-1, Adam Marszałek Publishing House, Toruń 2020.
3. Mitkow Sz., *Industrial Defence Potential of the Republic of Poland* [in:] The Logistics System of the Defence Potential of the Republic of Poland in the XXI Century. ISBN 978-83-8180-524-7, Adam Marszałek Publishing House, Toruń 2021.
4. Mitkow Sz., Kozicki B., Tomaszewski J., *Military Security and the Personal Potential of the Armed Forces of the Republic of Poland,* Jarosław Dąbrowski Military University of Technology, Warsaw 2021 - ISBN 978-83-7938-346-7.
5. Mitkow Sz., Kozicki B., Mizura G., *Planning the personnel potential of the Armed Forces of the Republic of Poland in the face of current challenges of military security,* Jarosław Dąbrowski Military University of Technology, Warsaw 2023 - ISBN 978-83-7938-346-0.
6. Fijałkowska S., Mitkow Sz., *Selected Psychological Determinants of Human Behaviour During the COVID-19 Pandemic* [w:] Information, Security and Society in the COVID-19 Pandemic. ISBN 978-10-323-1442-6, Routledge, Londyn 2022.
7. Mitkow Sz., (ed.), *Model of the functioning of the logistics system in the process of ensuring the defence capabilities of the Republic of Poland*, Adam Marszałek Publishing House, Toruń 2022, pp.280, ISBN 978-83-8180-634-3.
8. Misiuk A, Itrich-Drabarek J., Mitkow Sz., Bryczek-Wróbel P. (eds.), *Encyclopedia of National Security*, WAT, Warsaw 2023 -
9. Mitkow Sz., Bodziany M., Jałowiec T., Kępczyński A., Lis A., Pączek B., Skulimowski M., Urban K., (eds.). *Logistics system of the Armed Forces of the Republic of Poland*. *REPORT 2024*, Military University of Technology, Warsaw 2024, ISBN 978-83-7938-419-8.
10. Mitkow Sz., Pac B*., A comparative analysis of the logistic capabilities of selected land intermodal terminals: The Polish case study for states of emergency*, Polish Political Science Yearbook, 2024, DOI: 10.15804/ppsy202438.
11. Mitkow Sz., Mariak O., Chmielewski R., *Analysis rapid reconstruction airport pavements*, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, 2024, DOI: 10.37105/iboa.218.

Scientometric analysis (as of January 31, 2025):

Impact Factor = 3.476

Citations = 123 (citations counted from the Google Scholar database)

Hirsch index.

Hirsch Index = 2 (Hirsch Index from Web of Science and Scopus).

Hirsch Index = 4 (Hirsch Index from Google Scholar).

Total: 2210 points

Education activities
(modules, average number of hours of classes, in the last 5 years)

Academic year 2021/2022 number of hours: 520;
Academic year 2022/2023 number of hours: 500;
Academic year 2023/2024 number of hours: 628;
Academic year 2024/2025 number of hours: 440.
Courses:

1. Acquisition of military equipment.
2. Quantitative Methods in Logistics.
3. Basics of logistics.
4. Security Systems Engineering – a *course taught in SD.*
5. Research area analysis - *a course taught in SD.*
6. Basic of Logistics.
7. Quantitative Methods in Logistics.
8. Defence policy and planning for the development of military equipment.
9. Design of logistics systems and processes.
10. The life cycle of military equipment.
11. Production and distribution logistics management.
12. Safety and reliability of technical facilities. tag.

Achievements
(awards, distinctions, patents in the last 5 years)

Medal of the National Education Commission, Minister of Education and Science, 30.06.2021.

Air Cross of Merit, President of the Republic of Poland – 21.02.2022.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

The number of promoted doctors – 5.

Number of PhD reviews – 14.

Number of reviews in habilitation proceedings – 2.

Number of opinions in the habilitation procedure – 5.

Number of doctoral students at the WAT Doctoral School – 6.

Contact

Place of work: building no./room no.: building 135, room 1.18.

Tel.: 600 442 321

Email: szymon.mitkow@wat.edu.pl

Scientific Business Card

Title/degree Name and Surname, No ORCID

Adam OSTANEK, PhD DSc., ORCID 0000-0003-0801-811X

Position, management function

Associate Professor

Scientific discipline represented (scientific disciplines %)

- Security Science – 50%
- History – 50%

Area of scientific interest

security history, military history, internal security of the state

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

- Military History Section of the Committee on Historical Sciences of the Polish Academy of Sciences – member (since 2024)
- Association of Military Historians – president (since 2023)
- Senate of the Military University of Technology – member of the Committee for Science (since 2024)
- Council of the Scientific Discipline "Security Sciences" of the Military University of Technology (since 2020)
- Deputy Director for Research at the Institute of Organization and Management (2020–2024)
- Faculty Election Committee of the Faculty of Security, Logistics, and Management – chairman (term 2020–2024)
- Committee for the Mid-Term Evaluation of PhD Students of the Military University of Technology Doctoral School for the discipline of Security Science – chairman (2024)
- Team for the Development of Principles and Criteria for the Awarding of Academic Degrees in the discipline of Security Sciences at the Military University of Technology – member (2022)

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

- Scholarship from the Lanckoroński Foundation from Brzezie – 2022
- University Research Grant – 2021 (manager), 2022, 2023 (manager), 2024, 2025 (manager)

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Total number of publications: over 150 (various types)

Hirsch index:

- Google Scholar h-index: 6
- Web of Science h-index: 0
- Scopus h-index: 0

Most important publications:

1. Adam A. Ostanek, *Drugoplanowi ojcowie Niepodległej. Wilhelm Kalwas (1896–1978)*, „Kwartalnik Kresowy” 2025, vol. 1, p. 75–92.
2. Petro Hawrylyshyn, Adam A. Ostanek, *Bohdan Hawrylyshyn and the Club of Rome*, „Echa Przeszłości” 2025, vol. XXVI/1, p. 163–173.

3. *"Orzeł czy Rzeszka?" Nastroje społeczne mieszkańców województwa tarnopolskiego wobec zagrożenia wojennego i wojny 1939 roku w świetle dokumentów*, red. A.A. Ostanek, P. Pulik, Warszawa 2024.
4. Adam A. Ostanek, Marcin Mielnik, *Przygotowania reformy Gwardii Narodowej w 1811 r. Poprawienie bezpieczeństwa czy krok wstecz?*, „Studia z Dziejów Rosji i Europy Środkowo-Wschodniej" 2024, t. LIX, z. 2, p. 5–18.
5. Adam A. Ostanek, *Twierdza, która nie skapitulowała. Brześć nad Bugiem w kampanii polskiej 1939 roku*, [in:] *Оборонні війни: Польща 1939 – Україна 2022–2023*, відп. ред. А. Харук, Львів 2024, p. 121–137.
6. Adam A. Ostanek, *O bezpieczeństwo i porządek publiczny. Organizacja struktur terenowych Policji Państwowej w Małopolsce Wschodniej w pierwszych latach niepodległości (1919–1924)*, „Textus et Studia" 2023, vol. 1 (33), p. 29–47.
7. Adam A. Ostanek, *O nienaruszalność granic. Polsko-sowiecki spór polityczny o kształt wschodniej granicy Rzeczypospolitej po II wojnie światowej*, „Przegląd Wschodnioeuropejski" (Olsztyn) 2023, vol. XIV (1), s. 161–173.
8. Adam A. Ostanek, *The beginnings of the polish arms industry in the Second Polish Republic. "Arma" – The Arms and Machines Factory in Lviv*, "Wiedza Obronna" 2022, vol. 3, p. 363–375.
9. Adam A. Ostanek, *Rozszyfrowana wojna. Biuro Szyfrów Oddziału II Naczelnego Dowództwa Wojska Polskiego a losy bitwy warszawskiej 1920 roku*, „Przegląd Wschodnioeuropejski" (Olsztyn) 2021, vol. XII/2, p. 29–45.
10. Adam A. Ostanek, *Propaganda morska na Kresach Południowo-Wschodnich II Rzeczypospolitej, czyli rzecz o działalności Ligi Morskiej i Kolonialnej w okręgach wojewódzkich lwowskim, stanisławowskim i tarnopolskim w latach 1924–1939*, „Biuletyn Historyczny Muzeum Marynarki Wojennej" 2021, nr 36, p. 87–114.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Objects:

- Security History (including the SDR)
- History of Warfare
- History of Poland

Average number of teaching hours: 408 hours/academic year

Achievements

(awards, distinctions, patents in the last 5 years)

- Bronze Medal "For Merit to National Defense" – 2020
- Bronze Cross of Merit – 2021
- Bronze Medal "Armed Forces in the Service of the Homeland" – 2023
- Medal of the National Education Commission – 2025
- Title and Badge "Meritorious Academic Teacher of the Military University of Technology" – 2025

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

- Number of PhDs awarded: 2
- Number of PhD reviews: 5

Contact

Place of work: building no./room no.:
Faculty of Security, Logistics and Management of the Military University of Technology
building no. 135, room no.4.03
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SCIENTIFIC BUSINESS CARD

Title/degree Name and Surname, No ORCID

Prof. Mieczysław PAWLISIAK, ORCID 0000-0003-2501-8779

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

Security Sciences – 100%

Area of scientific interest

Military security, logistical security, national defence, logistical support and security (material, technical, transport, medical and infrastructural) of military institutions and units during the implementation of tasks in the country and abroad.

Organizational activities

(participation in the work of various bodies, functions performed, in the last 5 years)

Participation in the work of various bodies:

1. Member of the team of NATO logistics experts as part of the DEEP program - Program to Strengthen Defense Education in Partner Countries.
2. Chairman of the Scientific Council of the journal "Military Logistics Systems" in the years 2019 – 2022. Publisher: Military University of Technology.
3. Member of the International Program Council of the journal "Logistics and Trans-port". Publisher: International University of Logistics and Transport (MWSLiT) in Wrocław.
4. Member of the Editorial Board of the journal "Collection of Scientific Works" (Збірник наукових праць). Publisher: Military Academy in Odessa.
5. Deputy Scientific Editor of the publishing series – *"Military Logistics Library"*

Functions:

In the years 2017 – 2023, Director of the Institute of Logistics of the Faculty of Safety, Logistics and Management of the Military University of Technology

Research activities

(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Leading a team appointed to analyze and evaluate the existing solutions in force in the process of operating military equipment. This task was commissioned by the Head of the Inspectorate of Support of the Armed Forces.
2. Leading a research team commissioned by the Military Research and Implementation Center of the Food Service, whose task was to assess the usefulness for the army of a new second-generation canteen made of Tritan.
3. Managing the UGB 753/2022 WAT project entitled "Military mobility as a determinant of logistic security in the Armed Forces of the Republic of Poland". The results of the research were published in the form of a monograph published by the Adam Marszałek Publishing House in Toruń in 2022 entitled "Military mobility as a determinant of logistic security in the Armed Forces of the Republic of Poland" ISBN 978-83-8180-701-2.

4. Leading the research project UGB 845/2023 entitled "Virtualization of logistics processes as one of the determinants of logistics security of the Polish Armed Forces". The results of the research were published in a monograph entitled "Virtualization of logistics processes as one of the determinants of logistics security of the Polish Armed Forces", published by BEL Studio Warsaw Publishing House 2024, ISBN 978-83-7798-475-8

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

The most important publications:

1. Monograph "Perspectives of Logistic Security of the Armed Forces of the Republic of Poland", ed. Difin, Warsaw 2023, ISBN 978-83-8270-178-4, pp. 248
2. The monograph "The Logistics System of the Armed Forces of the Republic of Poland. Theory and Practice." ISBN 978 – 83- 8180- 555- 1. Adam Marszałek Publishing House Toruń 2021, pp. 376
3. Chapter "Methodological assumptions for the process of research on the impact of military mobility on the logistic security of the Armed Forces of the Republic of Poland". [in]: Military mobility as a determinant of logistic security in the Armed Forces of the Republic of Poland, ISBN 978-83-8180-701-2, Adam Marszałek Publishing House, Toruń 2022, pp. 5 – 16
4. Chapter "Requirements for logistic security of military units and institutions in the 21st century". [in]: Military mobility as a determinant of logistic security in the Armed Forces of the Republic of Poland, ISBN 978-83-8180-701-2, Adam Marszałek Publishing House, Toruń 2022, pp. 47 – 70
5. Chapter "Determinants of food security". [in]: Food Security of the Soldiers of the Armed Forces of the Republic of Poland in the Conditions of the Epidemic Crisis Caused by Biological Threat, ISBN 978-83-8180-534-6, Adam Marszałek Publishing House, Toruń 2022, pp. 23 – 53
6. Chapter "Logistic Security". [in]: Logistics in the State Security System, ISBN 978-83-66491-02-1, Difin Publishing House, Warsaw 2021, pp. 107 – 127
7. Article in the Maritime Security Yearbook Vol.: XVII, No: , 2023 "Mobility as a determinant of the logistic security of Polish military contingents" ISSN: 1898-3189 Ministry of Science and Higher Education: 70pts
8. Article in Military Logistics Systems 1/2024 volume 60 "Internet of Things as a tool for ensuring the material security of military units and institutions", eISSN: 2719-7689, ISSN:1508-5430, Ministry of Science and Higher Education: 70pts
9. Nutrients ISSN: 2072-6643, MNiSW: 140 AnAssessment of Daily Energy Expenditure of Navy Ship Crews and Officers Serving in the Polish Maritime Border Guard as an Indicator of Work Severity and Nutritional Security https://doi.org/10.3390/nu17060953 - 9 March 2025

Scientometric analysis (as of January 31, 2025):
Citations = 10 (citations counted from the Google Scholar database)

Teaching activities
(taught subjects, including SDR, average number of hours of classes, in the last 5 years)

Academic year 2021/2022 number of hours: 508;
Academic year 2022/2023 number of hours: 463;
Academic year 2023/2024 number of hours: 436;
Academic year 2024/2025 number of hours: 351.
Courses:

1. Logistical support in missions outside the country.
2. Command of a logistics subunit.
3. Practice of commanding and directing logistics and developing logistics exercises.
4. Peace and stabilization activities.
5. Research area analysis - a course taught in SD.
6. Practical aspects of logistics activities.
7. Executive logistics management in SZRP
8. Operational and logistical security of PKW outside the country.
9. Military logistics system (including NATO Logistics and PKW security).
10. Analysis of the armaments market.
11. Methodology of developing and conducting exercises in the Polish Armed Forces.
12. Medical security of troops in multinational missions and operations (NATO, EU).

Achieve
(awards, distinctions, patents in the last 5 years)

Medal of the National Education Commission, Minister of Education and Science, 30.06.2021.

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

The number of promoted doctors – 6.

Number of PhD reviews – 11.

Number of reviews in habilitation proceedings – 2.

Number of opinions in the habilitation procedure – 1.

The number of doctoral students at the Doctoral School of the Military University of Technology – 4.

Contact

Place of work: building no./room no.: WAT, ex. no. 135/ 1.16

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Note: no more than 4 pages, if you have any questions or comments, please contact: piotr.zalewski@wat.edu.pl tel. 603 889 905

Scientific Business Card

Title/degree Name and Surname, No ORCID

dr hab. Aleksandra Skrabacz, ORCID: 0000-0001-5958-810X

Position, management function

Associate Professor

Scientific discipline represented (scientific disciplines %)

Safety sciences (100%)

Area of scientific interest

internal security, social security, civil protection, rescue services, crisis management, social capital, migration processes

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

Head of postgraduate studies in 'Civil Protection and Defence against Contemporary Threats' (since 2023), Chair of the Scientific Committee of the International Scientific Conference 'Crisis Management – Civil Protection – Rescue' (since 2022), member of the Senate of the Military University of Technology for the 2024-2028 term; member of the Scientific Council of the Military University of Technology.

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

1. Diagnosis of the crisis in the social sphere, sub-team coordinator, [in:] Diagnosis of the global financial and economic crisis caused by the coronavirus pandemic in the economic, social, political and geopolitical areas, research team leader P. Soroka, Polish Industrial Lobby. Seminar 'For a better Poland', Warsaw 2021 (free of charge);
2. Activities of Crisis Management Teams during the COVID-19 pandemic, research team leader, research project carried out with a research grant from the Pomeranian University in Słupsk in 2021, research task no.: 7- 6-11 (270) - 21.6.11 (amount PLN 3,468.00 – 2021 report);
3. The functioning of local communities in terms of crisis management in pandemic conditions, research team leader, research project carried out with a research grant from the Pomeranian University in Słupsk in 2022, research project no.: 7-6-17 (234) - 22 June 2017 (amount: PLN 3,069.00 – report 2022);
4. Increasing development opportunities in the area of crisis management in border areas (module 2), research team member, Catholic University of Lublin in Lublin, National University of Water and Environmental Engineering in Rivne, 1 September 2022-30 November 2022 (free of charge);
5. Social capital management for the security of local communities, research team leader, University Research Grant No. 849/2023, Military University of Technology in Warsaw, 2023 (amount: PLN 54,800.15 – 2023 report);
6. Resilience of the state, including society, to real and potential local, regional (national) and international threats, research team leader, University Research Grant No. 760/2024, Military University of Technology in Warsaw, 2024 (amount: PLN 100,000.00 – report 2024);

Projects in progress:
Migration processes in the context of the demographic crisis at the national and international level, research team leader, University Research Grant No. 875/2025, Military University of Technology in Warsaw, 2025 (amount: PLN 40,000.00 – application 2025).

Applications submitted to the competition under the Ministry of Science and Higher Education's 'Science for the Development of Society' programme:
Consolidation of local entities for security – integration of the community for social cohesion, ID: 8d853d2d5a434a91a2eb52511516fdc3, research team leader, 2025–2028 (amount: PLN 861,300.00).

Publishing activities

(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

1. Skrabacz Aleksandra, Uncontrolled Migration as a Challenge for the Security of Microregions in the European Union, [w:] The impact of Rivalry : between China, Russia and the United States on security dynamics in the Eastern Hemisphere, B. Pacek, K. Rak, (red.), Warszawa 2021, ISBN 978-83-960228-2-0, ss. 121-128, razem s. 7;
2. Skrabacz Aleksandra, Impact of war refugees from Ukraine on security of Poland, Germany and Great Britain, [in:] The Migration Conference 2024 Selected Papers, Transnational Press London 2024, ISBN: 978-1-80135-321-2, ss. 237-244, razem s. 7;
3. 3. Skrabacz Aleksandra, The importance of social capital in creating security in local communities, Social Science Annals 2/2023, pp. 89–110, total 21, DOI: https://doi.org/10.18290/rns2023.0018;
4. Skrabacz Aleksandra, Bsoul-Kopowska Magdalena, Social capital as a foundation for Polish self-organisation for war refugees from Ukraine, Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska, 2023, ss. 513-534, razem s. 21, DOI:10.29119/1641-3466.2023.184.26;
5. Skrabacz Aleksandra, Bsoul-Kopowska Magdalena, Baylis Monika, Activation of the social capital of Poles and Britons for war refugees from Ukraine. Journal of Modern Science, 2024; 56(2), ss. 285-309, razem s. 24, https://doi:10.13166/jms/187206;
6. Skrabacz Aleksandra, Social Capital in Poland's National Security, Elipsa Publishing House, Warsaw 2025, ISBN: 978-83-8017-515-0 and DOI: 10.33896/978-83-8017-515-0, total 559 pages;
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11. Skrabacz Aleksandra, Wołoch Franciszek, Protective structures as a device of ensuring the safety of victims in a war situation, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych, 1(24), ss. 1-12, razem s. 12, https://dx.doi.org/10.37105/iboa.198;
12. Skrabacz Aleksandra, Pajka Aneta, Więckowski Bartłomiej, Crisis management as a researach province of security science, Roczniki Nauk Społecznych, tom 16(52)2024, ss. 7-25, razem s. 19, https://doi.org/10.18290/ms2024.0010;
13. Kozicki Bartosz, Skrabacz Aleksandra, A comparative analysis of injuries and deaths from road traffic accidents in Poland and selected EU countries, Transport Problems, 2024, Volume 19, Issue 1, ss. 57-67, razem s. 10, DOI: 10.20858/tp.2024.19.1.05;
14. Gajewska Paulina, Szewczyk Irena, Skrabacz Aleksandra, Evaluating and identifying hazards at pedestrian crossings, Transport Problems, 2024, Volume 19, Issue 3, ss. 155-168, razem s. 13, DOI: 10.20858/tp.2023.19.3.13;
15. Skrabacz Aleksandra, Moch Natalia, Stochaj Justyna, Bryczek-Wróbel Patrycja (ed.), Institutional and organisational aspects of civil protection, Elipsa Publishing House, Warsaw 2024, ISBN 978-83-8017-513-6, total 362 pages;

16. Skrabacz Aleksandra (red.), Protection of the public facing the threats of civilization and war, Roczniki Nauk Społecznych, vol. 52, nr 1(2024), https://czasopisma.tnkul.pl/index.php/rns/issue/view/76, razem s. 190;
17. Skrabacz Aleksandra, Moch Natalia, Stochaj Justyna, Bryczek-Wróbel Patrycja, (ed.), Civil protection in Poland in the face of legal and organisational changes, Elipsa Publishing House, Warsaw 2025, ISBN 978-83-8017-575-4, DOI 10.33896/978-83-8017-575-4, pp. 311.

Scientometric analysis (as of 31 January 2025):
Impact Factor = 2.5
Citations and self-citations counted from the Web of Science database: 1 and 0, respectively;
Citations and self-citations counted from the Scopus database: 4 and 0, respectively;
Citations counted from the Google Scholar database: 498;
The Hirsch index was:
from the Web of Science database = 1;
from the Scopus database = 2
from the Google Scholar database = 10.
from the Polish Scientific Bibliography database: number of publications – 68, number of points – 2,451;
from the WAT Knowledge Base: number of publications – 129, number of points – 2943.

Education activities

(modules, average number of hours of classes, in the last 5 years)

Academic year 2022/2023 number of hours: 315.5;
Academic year 2023/2024 number of hours: 531.5;
Academic year 2024/2025 number of hours: 352.5.
Courses taught: civil protection, crisis management, universal defence, migration processes, social security, non-governmental forms of security organisation, emergency response teams, demography, rescue services, education in civil protection.
Average grade according to students in the winter semester of the academic year 2023/2024 - 4.89.

Achievements

(awards, distinctions, patents in the last 5 years)

Bronze Cross of Merit (2023)

Experience in supervisor and reviewing work

(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

Liczba wypromowanych doktorów: ogółem 7.
Liczba recenzji prac doktorskich: 8 (w latach 2020-2025)
Liczba recenzji prac habilitacyjnych: 2 (w latach 2020-2025).

Contact

Place of work: building no./room no.: building 135, room 2.08.

Tel.: 727 147 322

Email: aleksandra.skrabacz@wat.edu.pl

Scientific Business Card

Title/degree Name and Surname, No ORCID

Wojciech WŁODARKIEWICZ, Professor, PhD DSc., ORCID: 0000-0002-4977-1135

Position, management function

Professor

Scientific discipline represented (scientific disciplines %)

- Security Science – 75%
- History – 25%

Area of scientific interest

security history, military history, internal security of the state

Organizational activities
(participation in the work of various bodies, functions performed, in the last 5 years)

- Ministry of National Defense – Committee for the Awards of the Minister of National Defense for Academic Teachers at Military Universities: 2022 member, 2023 chairman, 2024 member, 2025 member.
- Association of Military Historians – Vice President (since 2016)
- Senate of the Military University of Technology – (2020–2024)
- Council of the Scientific Discipline of "Security Science" at the Military University of Technology (since 2019)
- Director of the Institute of Organization and Management (2019–2024)

Research activities
(participation in programs, projects, grants, method of financing, in the last 5 years)

- University Research Grant – 2021, 2022 (manager), 2023, 2024 (manager), 2025

Publishing activities
(number of publications, Hirsch Index, information from the Web of Science database, Scopus, the most important publications in the last 5 years)

Total number of publications: over 220 (various types)

Hirsch index:

- Google Scholar h-index: 6
- Web of Science h-index: 0
- Scopus h-index: 0

Most important publications:

1. W. Włodarkiewicz, *Małopolska Wschodnia 1939*, Warszawa 2020.
2. W. Włodarkiewicz, *Zagrożenie bezpieczeństwa militarnego Rzeczypospolitej Polskiej przez związek radziecki w okresie międzywojennym*, „Przegląd Wschodnioeuropejski: 2022, vol. XIII/1, p. 49–62.
3. W. Włodarkiewicz, *Stosunki wojskowe między Rzecząpospolitą Polską a Związkiem Radzieckim w latach 1921–1939*, „Przegląd Wschodnioeuropejski” 2022, vol. XIII/2, p. 189–200.
4. W. Włodarkiewicz A. Wesołowski, *Bezpieczeństwo militarne Rzeczypospolitej Polskiej. Koncepcja przedmościa rumuńskiego w dokumentach*, Warszawa 2022.
5. W. Włodarkiewicz, *Uzbrojenie polskich formacji zbrojnych w I wojnie światowej i Wojska Polskiego w okresie walk o granice Rzeczypospolitej Polskiej*, [in:] *Świadectwa przeszłości. Studia z dziejów Południowego Podlasia, wojska, techniki i biografistyki*, red. A. Zawadzki, Siedlce 2023, p. 93–115.
6. J. Jończyk, W. Włodarkiewicz, A. Zając, K. Kolasińska-Morawska, R. Seliga, *Impact of Pandemic Covid-19 on the internationalization processes of universities in the*

perspective of own research, „The Prison Systems Review" („Law Education Security") 2023, vol. 4, 140 pkt.
7. J. Antczak, W. Włodarkiewicz, J. Doliński-Lesiuk, *Wpływ otoczenia makroekonomicznego na zarządzanie i współpracę z państwami Europy Środkowo-Wschodniej na przykładzie przedsiębiorstwa realizującego przewozy modalne*, „Studia Wschodnioeuropejskie" 2023, vol. 3, 140 pkt.
8. W. Włodarkiewicz, *Bezpieczeństwo wewnętrzne województw wschodnich Rzeczypospolitej Polskiej w latach 1921–1926*, [in:] *Polska bezpieczna czy nie? Służby specjalne - wojsko - dyplomacja w XX i XXI wieku*, red. Siewier, Częstochowa 2023, p. 507–524.
9. W. Włodarkiewicz, A. Wesołowski, *Bezpieczeństwo militarne Rzeczypospolitej Polskiej. Przedmoście rumuńskie w relacjach i we wspomnieniach*, Warszawa 2024.

Education activities
(modules, average number of hours of classes, in the last 5 years)

Objects:

- Security History (including the SDR)
- History of Warfare
- History of Poland
- Economic history

Average number of teaching hours: 300 hours/academic year

Achievements
(awards, distinctions, patents in the last 5 years)

- Gold Cross of Merit – 2025
- Award of the Rector-Commander of the Military University of Technology for the entire scientific achievements – 2023

Experience in supervisor and reviewing work
(number of promoted doctors, number of reviews: doctoral students, in habilitation proceedings, opinions in professorial proceedings, in the last 5 years)

- Number of PhDs awarded: 6
- Number of PhD reviews: 30
- Number of reviews in habilitation proceedings: 2
- Number of reviews in professorship proceedings: 2

Contact

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Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 35/WAT/2019 of 30 May 2019

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (Journal of Laws, item 1668, as amended), in connection with the Article 291 of the Act of 3 July 2018. The provisions introducing the Act – Law on Higher Education and Science (Journal of Laws, item 1669, as amended) are hereby adopted as follows:

§ 1

The "Rules of Recruitment to the Doctoral School of the Military University of Technology for the academic year 2019/2020" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

(--) Big. Gen. Prof. Tadeusz SZCZUREK

Attachment to Resolution No. 35/WAT/2019 of the WAT Senate
of 30 May 2019

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2019/2020

§ 1

1. The Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2019/2020, in the following scientific disciplines:
    1) automation, electronics and electrical engineering;
    2) technical informatics and telecommunications;
    3) civil engineering and transportation;
    4) materials engineering;
    5) mechanical engineering;
    6) safety sciences;
    7) chemical sciences.

2. A person who holds a master's degree, a master's degree in engineering or an equivalent degree or is a beneficiary of the "Diamond Grant" program may be admitted to the Doctoral School.

3. In exceptional cases, justified by the highest quality of scientific achievements, a person who is a graduate of first-cycle studies or a student who has completed the third year of long-cycle master's studies may be admitted to the Doctoral School.

4. The rules and procedure for sending professional soldiers to the Doctoral School
in the official mode are regulated by the provisions *of the Act of 11 September 2003.*
on the military service of professional soldiers (t.j.Dz. U. of 2019, item 330).

5. Candidates with disabilities are subject to the same recruitment procedure as other candidates applying for admission to the Doctoral School.

6. The limit of places for the Doctoral School is set by the Rector at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".

§ 2

1. The recruitment procedure is conducted by the Doctoral School Admissions Committee appointed by the Rector, hereinafter referred to as the "Admission Committee". The chairman of the recruitment committee is the director.

2. The admission procedure to the Doctoral School consists of the following stages:
   1) the submission by the candidates of the documents referred to in paragraph 5;
   2) verification of documents;
   3) the qualification procedure – awarding ranking points by the recruitment committee;
   4) entry on the list of doctoral students or issuance of an administrative decision
      on refusal of admission to the Doctoral School.

3. A candidate for the Doctoral School submits to the admissions committee the documents
   referred to in paragraph 5 between **1 July 2019 and 19 August 2019:**
   1) in person or by another duly authorised person;
   2) by mail.

4. A candidate may apply for admission in only one scientific discipline conducted at the Doctoral School.

5. The candidate submits the following documents to the Dean's Office of the Doctoral School:
   1) application for admission together with a personal questionnaire, according to the template contained in Appendix No. 3;
   2) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of master's, master's degree in engineering or equivalent - does not apply to candidates referred to in § 1 section 3;
   3) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies - applies to candidates referred to in § 1 section 3;
   4) the original or a copy certified by the Dean's Office of the Doctoral School of the Diploma Supplement or other document confirming the course of studies;
   5) the original or a copy certified by the Dean's Office of the Doctoral School of the document confirming obtaining the "Diamond Grant" - applies only to the candidate, beneficiary of the "Diamond Grant" program);
   6) two current and signed photographs in the format provided for an identity document;
   7) the original or a copy certified by the Dean's Office of the Doctoral School of documents confirming scientific achievements, professional experience coinciding with the selected scientific discipline and predispositions for research work, including publications and activity in the scientific movement, if they have been mentioned in the questionnaire;

8) the original or a copy of language certificates certified by the Dean's Office of the Doctoral School;
9) curriculum vitae (CV);
10) an information clause resulting from the Act of 10 May 2018 on the protection of personal data (Journal of Laws of 2018, item 1000) and Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (GDPR) – according to the template contained in Annex 4;
11) in the case of possession of a certificate of disability or a certificate on the degree of disability or a certificate referred to in Article 5 and Article 62 of the Act of 27 August 1997. on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2018, item 511) – a copy of this decision.

6. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act of 20 July 2018 – Law on Higher Education and Science apply to the recognition of a diploma as entitling to undertake education at a doctoral school
.

7. In the event of submitting incomplete documents in the recruitment procedure, the recruitment committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate is not admitted to the qualification procedure.

8. An application referred to in paragraph 5(1) submitted or submitted after the deadline specified in paragraph 3 shall be returned without examination.

§ 3

1. The recruitment procedure is of a competitive nature.

2. Graduates of fields of study providing second-cycle qualifications, hereinafter referred to as "master's studies", may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1, subject to § 1 section 2 and section 3. A detailed list of fields of study is contained in Appendix No. 1.

3. In the case of a person holding a diploma of completion of a Master's degree programme other than that listed in Appendix 1 or studies completed outside Polish, the Admission Committee decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline. The admissions committee may ask the candidate to submit additional documents.

4. In the recruitment procedure, subject to § 1 sections 2 and 3, the Admission Committee awards ranking points to candidates, taking into account:
   1) the result of the candidate's completion of the master's degree;
   2) qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline;
   3) scientific achievements of the candidate.

5. The maximum number of points that can be awarded by the admissions committee is 100.

6. Detailed rules for calculating the candidate's ranking points are specified in Appendix No. 2.

7. In the event that a beneficiary of the "Diamond Grant" program applies for admission, the admissions committee decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline and awards the candidate with the maximum number of ranking points.

8. In the case of candidates referred to in § 1 section 3, the Admission Committee decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline and awards the candidate with the maximum number of ranking points.

§ 4

1. The results of the recruitment procedure are public and will be announced by **6 September 2019.**

2. The recruitment committee draws up a protocol on the recruitment process, to which a document called the ranking list of candidates is attached. The order in which candidates are placed on the ranking list is determined by the number of ranking points (from the highest to the lowest number of points). The ranking list includes:
   1) the names and surnames of the candidates and the codes assigned to them;
   2) the number of ranking points awarded for each element of the procedure assessed, in accordance with Annex 2;
   3) the final result of the candidates – the sum of the ranking points;
   4) indicating whether the candidate has been qualified to be entered on the list of doctoral students of the Doctoral School.

   The ranking list with codes instead of names and surnames of candidates is subject to publicity.

3. The protocol is signed by the members of the recruitment committee, and the ranking list is signed by the chairperson of the recruitment committee.

4. The protocol is signed by the members of the recruitment committee who took part in the recruitment procedure. Any deletions and changes made to the

ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the committee.

5. The admission of a candidate to the Doctoral School in the academic year 2019/2020, within the limit of places for a scientific discipline, is determined by the order of places on the ranking list ranked according to the decreasing number of points.

6. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
    1) achievements referred to in § 3 section 4 point 3;
    2) the result referred to in § 3 section 4 point 1;
    3) qualifications and competences referred to in § 3 section 4 point 2.

7. In the absence of a decision on the basis of the conditions referred to in paragraph 5, the decision on admission to the Doctoral School is made by the admissions committee.

§ 5

1. Admission to the Doctoral School takes place by entering the list of doctoral students.

2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

§ 6

1. The rules set out in the resolution apply to Polish citizens.

2. Persons who are not Polish citizens may undertake and complete education at the Doctoral School on the terms set out in the Act of 20 July 2018 – Law on Higher Education and Science.

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

List of fields of study whose graduates may apply for admission to the Doctoral School

Scientific discipline conducted at the Doctoral School	Completed Master's degree
Automation, Electronics and Electrical Engineering	- Automation and robotics - Electronics - Electronics & Telecommunications - electrical engineering - Energy - physics - Technical physics - Photonics - Materials Engineering - Mechatronics - computer science
Technical Informatics and Telecommunications	- Automation and robotics - Electronics & Telecommunications - computer science - Computer Science and Econometrics
Civil Engineer & Transportation	- Construction - Geodesy and Cartography - geophysics - geography - geology - physics - computer science - navigation
Materials Engineering	- chemistry - physics - Technical physics - chemical and process engineering - Materials Engineering - Production Engineering - mechanics and mechanical engineering - metallurgy - Chemical Technology
Mechanical Engineering	- Materials Engineering - logistics - mechanics and mechanical engineering - Mechatronics - transport - Production Management and Engineering - Automation and robotics - Technical physics - Aerospace
Chemical Sciences	- chemistry - Chemical Technology - chemical and process engineering - biotechnology - Materials Engineering - biochemistry - environmental protection - Environmental Engineering - physics
Security Sciences	- National security - internal security - European Studies - Safety Engineering - logistics - political science - international relations - management - National defence - State security management

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

Detailed rules for calculating candidate ranking points

The Admission Committee awards the candidate's ranking points on the basis of:

Basis for calculating ranking points	Number of Ranking Points
1. Result of completion of the master's degree	0 ÷ 50
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 20
3. Scientific achievements	0 ÷ 30

1. On the basis of the assessment of the completion of the Master's degree, the Admission Committee awards ranking points according to the following rules:

Result of completion of the master's degree	Number of Ranking Points
5w	50
5	45
4+	40
4	30
3+	0
3	0

2. The assessment of the candidate's qualifications and competences is carried out by the recruitment committee and points are awarded according to the following rules:

Qualifications and competencies of the candidate	Number of Ranking Points
1) motivation to conduct research work	0 ÷ 10
2) documented research internships, individual studies	0 ÷ 5
3) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
4) Language certificate	0 ÷ 2

1) the candidate's motivation to conduct research work - up to 10 points is estimated on the basis of the information provided in the information questionnaire;
2) documented scientific internships, individual studies – up to 5 points on the basis of certificates;
3) certificates and certificates proving the acquisition of qualifications needed for scientific work – up to 3 points

on the basis of copies of certificates, certificates and attestations;

4) A certificate of foreign language proficiency – up to 2 points:
   a. lack of certificate or below B2 level – 0 points;
   b. at B2 level - 1 point;
   c. at a level above B2 – 2 points.

3. The candidate's scientific achievements are assessed by the recruitment committee and points are awarded according to the following rules:

Candidate's scientific achievements	Number of Ranking Points
1) Documented scientific publications	0 ÷ 30
2) documented awards and scholarships of the Ministry of Science and Higher Education, Rector's awards and scholarships, distinctions for the best diploma thesis, other awards and recognitions for research activities	0 ÷ 10
3) documented achievements in the Students' Scientific Club (KNS)	0 ÷ 5

Note: *the sum of points for the candidate's scientific achievements cannot exceed 30, priority is given to points for documented scientific publications.*

1) For documented scientific publications in a selected scientific discipline, the Admission Committee awards points according to the following rules:
   a. monograph in a scientific discipline – up to 15 points;
   b. a chapter in a multi-author monograph – up to 5 points;
   c. scientific publication in journals from the list of journals of the Ministry of Science and Higher Education – up to 10 points;
   d. scientific publication in journals outside the list of journals of the Ministry of Science and Higher Education – up to 5 points;
   e. participation in a scientific conference with a presentation of a paper – up to 3 points;
   f. paper in conference materials - up to 2 points

   The sum of points cannot exceed 30.

2) for documented awards and scholarships of the Ministry of Science and Higher Education, Rector's awards and scholarships, other awards and recognitions for research activities, the Admission Committee awards points according to the following rules:
   a. obtaining an award and a scholarship from the Ministry of Science and Higher Education – up to 5 points;
   b. obtaining an award and a scholarship from the Rector of a higher education institution – up to 3 points;
   c. distinction for the best diploma thesis – up to 2 points

   The sum of points cannot exceed 10.

3) for documented achievements in the KNS, the recruitment committee awards points according to the following rules:
   a. distinction in the competition for the best student work within the activities of the KNS - up to 5 points;
   b. distinction for speaking at the KNS seminar - up to 2 points

   The sum of points cannot exceed 5.

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

/TEMPLATE OF THE APPLICATION FOR ADMISSION TO THE DOCTORAL SCHOOL TOGETHER WITH THE INFORMATION QUESTIONNAIRE/

..... *....., ...*
Candidate's name *locality* *data*

RECTOR
Military University of Technology

REQUEST

I would like to ask you to accept me to the Doctoral School of the Military University of Technology in the scientific discipline of .....
for the academic year 2019/2020.

Attached is an information questionnaire with documents confirming qualifications, competences and scientific achievements.

....
city, date *Candidate's signature*

Attachments:

1. Information questionnaire.
2. Diploma confirming obtaining a professional title.
3. Diploma Supplement.
4. A document confirming obtaining the "Diamond Grant".
5. 2 Photography.
6. Documents confirming scientific achievements, professional experience.
7. Language certificates.
8. Curriculum vitae (CV).
9. Information clause.
10. Disability certificates.

INFORMATION QUESTIONNAIRE

1. Identification data of the applicant:

surname..... Name 1 ..... 2 .....

family name (for married women) .....

father/mother's name.....

Date of Birth *(dd-MM-yyyy):* ..... - ..... - ..... PESEL ....

Place of birth..... country.....

citizenship..... ID card series and number..... ....

2. Permanent residence registration address:

locality:..... hive.:.....

Thought No. : ..... Room No. : .....

Postal code: ..... - ..... mail:.....

voivodeship:.....

country:.....

....

3. Correspondence address: *(if different from the address of residence)*

locality:..... hive.:.....

Thought No. : ..... Room No. : .....

Postal code: ..... - ..... mail:.....

country:.....

.....

4. Contact:

a) landline.....

b) mobile phone.....

c) Email.....

5. Master's degree diploma:

a) University Name:

.....

b) Completed field of study: .....

c) Result of completing master's studies: .....

d) No., date and place of issue of the diploma: .....

e) Master's thesis title:.....

.....

.....

f) title, academic degree, name and surname of the supervisor of the master's thesis (supervisor)

.....

6. Do you have a doctoral degree? If so, please indicate when and where it was obtained and in which scientific discipline

.....

7. Have you had or have you initiated a doctoral dissertation? If so, please indicate where and in which scientific discipline

.....

8. Professional career in the last three years:

Period	Name of the workplace	Locality	Position

9. Please state the reasons for your decision (motivation) to apply for the Doctoral School and conduct research in the selected discipline

……

……

……

……

10. Please indicate your preferred subject matter of the research work (individual research plan) within the selected scientific discipline

……

……

……

11. Please provide the title, academic degree, name and place of work of the person who has initially agreed to act as a supervisor:

……

……

12th Please list the scientific internships and individual studies referred to in Appendix 2 section 2 item 2 (documents certifying § 2 section 5 point 7)

……

……

……

13. Please list the certificates and certificates proving the acquisition of qualifications needed for scientific work in accordance with Appendix No. 2 section 2 item 3 (certifying documents in accordance with § 2 section 5 point 7)

……

……

……

14. Please list the certificates of knowledge of a foreign language in accordance
with Appendix No. 2 section 2 item 4 (certifying documents in accordance with § 2 section 5 point 8)

……

……

……

15. Please list scientific publications in the selected scientific discipline in accordance with Appendix No. 2 section 3 item 1 (certifying documents in accordance with § 2 section 5 point 7)

a) Monograph in a scientific discipline

……

……

……

b) chapter in a multi-author monograph

……

……

……

c) scientific publication in journals from the list of journals of the Ministry of Science and Higher Education

……

……

……

d) scientific publication in journals outside the list of journals of the Ministry of Science and Higher Education

……

……

……

16. Please list conferences and scientific papers in accordance with Appendix 2 section 3 item 1 (certifying documents in accordance with § 2 section 5 point 7)

a) participation in a scientific conference with presentation of a paper

……

……

……

b) paper in conference materials

……

……

……

17. Please list the awards and scholarships received in accordance with Appendix No. 2 section 3 item 2 (certifying documents in accordance with § 2 section 5 point 7)

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18. Please list the achievements in the Students' Scientific Club in accordance
with Appendix No. 2 section 3 item 3 (certifying documents in accordance with § 2 section 5 point 7).

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19. Please provide the name of a person who can give an opinion on your predispositions for scientific work

a) .....

title, degree, name, surname, place of work and email address

....

city, date signature of the candidate

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of a provision of law, i.e. on the basis of Article 6(1)(c) of the GDPR in conjunction with Article 200 of the Act of 20 July 2018. Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) and pursuant to Article 9(2)(b) of the GDPR in conjunction with Article 209(7) of the Act of 20 July 2018. The Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) - for the purposes of recruitment, and after admission to the Doctoral School, will be processed on the basis of the law, i.e. on the basis of Article 6(1)(c) of the GDPR in conjunction with Article 201 of the Act of 20 July 2018. Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) and pursuant to Article 9(2)(b) of the GDPR in conjunction with Article 209 of the Act of 20 July 2018. Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended).
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit for doctoral studies. As for providing data on disability – providing them is voluntary, however, failure to provide this information will make it impossible to receive a doctoral scholarship in an increased amount.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;

8. You have the right to access the content of your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....

city, date *legible signature of the candidate*

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 123/WAT/2020 of 27 February 2020

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85), in connection with the with § 21 section 1 point 27 of the Statute of the Military University of Technology constituting an annex to the resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019) The following is resolved:

§ 1

The "Rules of Recruitment to the Jarosław Dąbrowski Military University of Technology Doctoral School for the academic year 2020/2021" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

/--/ Brig. Gen. Prof. Tadeusz SZCZUREK

Attachment
to Resolution No. 123/WAT/2020 of the Senate of the Military University of Technology
of 27 February 2020

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2020/2021

§ 1

1. The Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2020/2021, in the following scientific disciplines:
   1) automation, electronics and electrical engineering;
   2) technical informatics and telecommunications;
   3) civil engineering and transportation;
   4) materials engineering;
   5) mechanical engineering;
   6) safety sciences;
   7) chemical sciences.
2. A person who holds a master's degree, a master's degree in engineering or an equivalent degree or is a beneficiary of the "Diamond Grant" program may be admitted to the Doctoral School.
3. In exceptional cases, justified by the highest quality of scientific achievements, a person who is a graduate of first-cycle studies or a student who has completed the third year of long-cycle master's studies may be admitted to the Doctoral School.
4. The rules and procedure for the referral of professional soldiers to the Doctoral School are regulated by the provisions *of the Act of 11 September 2003. on military service of professional soldiers* (i.e. Journal of Laws of 2019, item 330, as amended).
5. Candidates with disabilities are subject to the same recruitment procedure as other candidates applying for admission to the Doctoral School.
6. The limit of places for the Doctoral School is set by the Rector at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".

§ 2

1. The recruitment procedure is conducted by the Doctoral School Admissions Committee appointed by the Rector, hereinafter referred to as the "Admission Committee".
2. The recruitment committee consists of:
   1) chairman – director;
   2) at least three academic teachers holding the degree of habilitated doctor or the academic title of professor representing each of the scientific disciplines referred to in § 1 section 1;
   3) other persons indicated by the headteacher.
3. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
4. In justified cases, at the request of the Chairperson, the Rector may appoint new or dismiss already appointed members of the Recruitment Committee.

5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The Recruitment Committee is appointed by the Rector for the period from 16 March 2020 to 31 December 2020.
7. The Recruitment Committee appoints from among the members of the Committee qualification teams for scientific disciplines, hereinafter referred to as "teams", to conduct the qualification procedure referred to in § 4 section 1 points 4 and 5. The recruitment committee appoints the chairman of the team.
8. In special cases, the composition of the teams may be modified by the committee. The chair of the panel convenes the meetings of the team and chairs its deliberations.
9. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
10. The meetings of the recruitment committee are recorded. The minutes are signed by the chairman and other members of the committee participating in the meeting.
11. The Recruitment Committee makes decisions in the form of resolutions. Resolutions are adopted by a simple majority of votes, in the presence of at least half of the members of the committee. In the event of an equal number of votes, the chairman's vote is decisive.
12. In the absence of the chairperson, the meeting of the committee shall be convened
    and chaired by a member of the committee authorised by the chairperson.

§ 3

1. A member of the recruitment committee is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the admissions committee shall inform the chairperson of the admissions committee of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School. The Selection Committee may decide to exclude a member of the Board from the evaluation procedure of a given candidate if the participation of that member could raise reasonable doubts.
3. A member of the Recruitment Committee is subject to exclusion from the assessment of a candidate
   , in particular if:
   1) plans to take on the duties of a supervisor or assistant supervisor of the candidate;
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) has participated in disciplinary proceedings in which a candidate for a doctoral school or a candidate for its supervisor has been accused;

7) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.

4. The exclusion of a member of the recruitment committee from the assessment of a given candidate is recorded in the minutes of the committee meeting.

§ 4

1. The admission procedure to the Doctoral School consists of the following stages:
   1) registering the candidate in the Internet Candidate Registration System (IRK);
   2) the submission by the candidate of the documents referred to in paragraph 4;
   3) verification of the completeness of the submitted documents;
   4) qualification procedure:
      a. analysis of the compliance of the Master's degree programme completed by the candidate with the list of fields of study included in Appendix No. 1 or, in the case of candidates referred to in paragraph 2, an assessment of the relationship between the candidate's scientific achievements and one of the scientific disciplines indicated in § 1 section 1;
      b. awarding ranking points by the Recruitment Committee for:
         – the result of completing master's studies,
         – qualifications and competences for education at the Doctoral School,
         – scientific achievements,
      c. awarding ranking points by the admissions committee for an interview;
   5) establishing a ranking list of candidates in individual scientific disciplines;
   6) entering into the list of doctoral students or issuing an administrative decision
      on refusal of admission to the Doctoral School.
2. In the case of beneficiaries of the "Diamond Grant" programme and candidates referred to in § 1 section 3, the recruitment procedure does not include the activities specified in paragraph 1 point 4 letter b.
3. A candidate for the Doctoral School registers in the IRK system **from 17 August 2020 to 30 August 2020.**
4. After registering in the IRK system, the candidate submits to the Dean's Office of the Doctoral School by **1 September 2020.** the following documents**:**
   1) an application for admission to the Doctoral School generated from the IRK system;
   2) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of master's, master's degree in engineering or equivalent - does not apply to candidates
      referred to in § 1 section 3;
   3) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies - applies to candidates referred to in § 1 section 3;

4) the original or a copy certified by the Dean's Office of the Doctoral School of the Diploma Supplement or other document confirming the course of studies;
5) the original or a copy certified by the Dean's Office of the Doctoral School confirming obtaining the "Diamond Grant" - applies only to the candidate, beneficiary of the "Diamond Grant" program;
6) professional questionnaire (Appendix No. 3) together with originals or copies certified by the Dean's Office of the Doctoral School confirming professional experience, qualifications and competences for education at the Doctoral School;
7) a scientific questionnaire (Appendix No. 4) with originals or copies of documents confirming scientific achievements certified by the Dean's Office of the Doctoral School;
8) curriculum vitae (CV);
9) information clause concerning the processing of personal data – according to the template contained in Appendix No. 5.

5. The application with the documents can be submitted by the candidate
   1) in person or by another duly authorised person;
   2) by mail.
6. A candidate may submit an application and apply for admission to the Doctoral School only in one of the scientific disciplines referred to in § 1 section 1.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act of 20 July 2018 – Law on Higher Education and Science apply to the recognition of a diploma as entitling to undertake education at a doctoral school .
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the requirements referred to in § 1 section 2 or § 1 section 3, the recruitment committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.
9. An application referred to in paragraph 4(1) submitted or submitted after the deadline specified in paragraph 4 shall be left unexamined.

§ 5

1. The admission fee for registration to the Doctoral School is PLN 100.
2. The candidate pays the recruitment fee no later than on the date of completion of registration in the IRK system, i.e. 30 August 2020.
3. The candidate makes a payment to an individual bank account generated for each candidate by the IRK system.
4. In a particularly justified case, the candidate may, by 30 August 2020, submit an application to the Rector for exemption from the recruitment fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
5. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.

6. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 4 or the expiry of the deadline referred to in paragraph 5, the candidate shall not be subject to the qualification procedure.
7. The candidate is entitled – at his/her request – to a refund of the recruitment fee
   in the event of:
   1) resignation from participation in the qualification procedure before its commencement, i.e. before 7 September 2020;
   2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

§ 6

1. The recruitment procedure is of a competitive nature.
2. Candidates who are graduates of fields of study providing second-cycle qualifications, hereinafter referred to as "master's studies", may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1, subject to paragraph 12, a detailed list of fields of study is contained in Appendix No. 1.
3. In the case of a person holding a diploma of completion of a master's degree programme other than that listed in Appendix 1 or studies completed outside Polish, the team competent for the scientific discipline selected by the candidate decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline. The team may ask the candidate to present additional documents at the interview.
4. In the qualification procedure within individual scientific disciplines, the teams award ranking points to candidates on the terms set out in Appendix No. 2 and submit them to the recruitment committee for approval.
5. The number of ranking points of the candidate for each criterion is the arithmetic average of the points awarded by each team member, rounded up to the second decimal place, and cannot be greater than the maximum value specified for the criterion.
6. The interview with the candidates is conducted and the ranking points are awarded by a team of at least three people.
7. Information about the individual date and place of the interview is provided to candidates via the IRK system, by e-mail and on the website of the Doctoral School by 5 September 2020.
8. The maximum number of ranking points that can be awarded by the admissions committee is 100.
9. **A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only if they meet the formal requirements and obtain a total of at least 50 ranking points, including at least 20 points from the interview.**
10. Failure to meet the conditions referred to in paragraph 9 makes it impossible to enter the candidate on the list of doctoral students even if the limit of places for the scientific discipline is not used.
11. Detailed rules for calculating the candidate's ranking points are specified in Appendix No. 2.

12. In the case of beneficiaries of the "Diamond Grant" programme and candidates referred to in § 1 section 3, the relevant team:
    1) decides whether the candidate's scientific achievements are related to the scientific discipline referred to in § 1 section 1,
    2) if the condition specified in point 1 is met, the candidate is awarded 60 points,
    3) conducts an interview in accordance with paragraphs 4-8.
13. Before accepting the teams' proposals to award ranking points to candidates, the Recruitment Committee may commission the team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.

§ 7

1. The results of the recruitment procedure are public and will be announced by **16 September 2020.**
2. The recruitment committee draws up a protocol on the recruitment process, to which a document called the ranking list of candidates is attached.
3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the conditions referred to in § 6 section 9.
4. Candidates who do not meet the conditions referred to in § 6 section 9 are placed on the ranking list in a separate group below the candidates who meet these conditions.
5. The ranking list includes:
    1) names and surnames of candidates;
    2) the number of ranking points awarded for each criterion evaluated, in accordance with Appendix No. 2;
    3) the final result of the candidates – the sum of the ranking points;
    4) indicating whether the candidate has been qualified to be entered on the list of doctoral students of the Doctoral School.
6. The protocol is signed by the members of the recruitment committee, and the ranking list is signed by the chairperson of the recruitment committee.
7. The protocol is signed by the members of the recruitment committee who took part in the recruitment procedure. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the committee.
8. The admission of a candidate to the Doctoral School for the academic year 2020/2021, within the limit of places for a scientific discipline, is determined by the order of places on the ranking list ranked according to the decreasing number of points, provided that they meet the formal requirements and obtain a total of at least 50 ranking points, including at least 20 points from the interview.
9. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
    1) an interview referred to in § 4 section 1 point 4 letter c;
    2) scientific achievements referred to in § 4 section 1 point 4 letter b indent 3;
    3) the result of graduation referred to in § 4 section 1 point 4 letter b indent 1;
    4) qualifications and competences referred to in § 4 section 1 point 4 letter b, indent 2.

10. In the absence of a decision on the basis of the conditions referred to in paragraph 9, the decision on admission to the Doctoral School is made by the admissions committee.

§ 8

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

§ 9

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a separate competition procedure, outside the limits of places specified in § 1 section 6.
2. Only people who meet the conditions of the "Implementation Doctorate" program, in particular employees of companies cooperating with the Military University of Technology, can take part in the implementation recruitment.
3. The schedule for conducting the implementation recruitment, the template of the application submitted by the potential supervisor and the candidate's application, together with a list of documents that the candidate is obliged to submit at each stage of the implementation recruitment, is determined by the recruitment committee and made public on the website of the Doctoral School of the Military University of Technology by 20 March 2020.
4. Implementation recruitment is carried out by the recruitment committee in two stages:
    1) preliminary stage;
    2) final stage, subject to paragraph 7.
5. The initial stage includes:
    1) assessment of the draft proposal prepared by the potential promoter;
    2) assessment of the candidate's fulfilment of the formal requirements for participation in the programme on the basis of the documents referred to in paragraph 3;
    3) qualification procedure referred to in § 4 section 1 points 2-5.
6. After the completion of the initial stage, the candidate is entered on the ranking list of candidates for admission to the Doctoral School under the program and an application is submitted to the Minister of Science and Higher Education (MNiSW) to qualify WAT to participate in the "Implementation Doctorate" program, or in the event of a negative assessment of the draft proposal prepared by a potential supervisor or the candidate fails to meet the formal requirements or does not obtain it during the procedure qualification of the minimum number of points specified in § 6 section 9, the candidate receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2020/2021 under this programme.

7. The final stage is carried out only if the Ministry of Science and Higher Education provides information on the qualification of the WAT proposal for participation in the "Implementation Doctorate" programme, together with information on the number of doctoral students who can be admitted to the Doctoral School under this programme for the academic year 2020/2021 and the amount of financial resources broken down by academic years.
8. If the Ministry of Science and Higher Education provides information about the non-qualification of the WAT application for participation in the "Implementation Doctorate" programme, the Rector issues a decision to refuse admission of the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
9. The final stage applies only to candidates who have been entered on the ranking list for admission to the Doctoral School under the program at the initial stage and includes:
    a. registration of the candidate in the IRK system;
    b. payment by the candidate of the recruitment fee referred to in § 5 section 1;
    c. the candidate provides the documents referred to in paragraph 3;
    d. the recruitment committee conducts the qualification of candidates from the ranking list for admission to the Doctoral School, taking into account the limits of places referred to in paragraph 7 and the candidate's fulfilment of the requirements for participation in the programme.
10. The admissions committee may ask the candidate to submit additional documents confirming that they meet the requirements to participate in the program.
11. As a result of the final stage, the candidate is entered on the list of doctoral students of the Doctoral School for the academic year 2020/2021 as part of the "Implementation Doctorate" program, or receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2020/2021 under this program
12. The candidate's participation in the induction recruitment does not preclude his/her participation in the recruitment to the Doctoral School for the academic year 2020/2021.

§ 10

1. The rules set out in the resolution apply to Polish citizens.
2. Persons who are not Polish citizens may undertake and complete education at the Doctoral School on the terms set out in the Act of 20 July 2018 – Law on Higher Education and Science.

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

List of fields of study whose graduates may apply for admission to the Doctoral School

Scientific discipline conducted at the Doctoral School	Completed Master's degree
Automation, Electronics and Electrical Engineering	- Automation and robotics - electronics - Electronics & Telecommunications - electrical engineering - Energy - physics - Technical physics - Photonics - Materials Engineering - Mechatronics - computer science
Technical Informatics and Telecommunications	- Automation and robotics - Electronics & Telecommunications - electrical engineering - computer science - Computer Science and Econometrics
Civil Engineer & Transportation	- Construction - Geodesy and Cartography - geophysics - geography - geology - physics - computer science - navigation
Materials Engineering	- chemistry - physics - Technical physics - chemical and process engineering - Materials Engineering - Production Engineering - mechanics and mechanical engineering - metallurgy - Chemical Technology
Mechanical Engineering	- Materials Engineering - logistics - mechanics and mechanical engineering - Mechatronics - transport - Production Management and Engineering - Automation and robotics - Technical physics - Aerospace
Chemical Sciences	- chemistry - Chemical Technology - chemical and process engineering - biotechnology - Materials Engineering - biochemistry - environmental protection - Environmental Engineering - physics
Security Sciences	- National security - internal security - European Studies - Safety Engineering - logistics - political science - international relations - management - National defence - State security management

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

Detailed rules
calculating the candidate's ranking points

The team referred to in § 2 section 7 of the Recruitment Rules awards ranking points to the candidate on the basis of the following criteria:

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in point 5
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Interview	0 ÷ 40	0÷ 40

1. On the basis of the assessment of completion of the Master's degree programmes , the team referred to in § 2 section 7 of the Recruitment Rules awards ranking points according to the following rules:

Completion Score Master's Degree	Number of points Ranked
5w	20
5	15
4+	10
4	5
less than 4	0

2. The assessment of the candidate's qualifications and competences is carried out by the team referred to in § 2 section 7 of the Recruitment Rules and awards ranking points according to the following rules:

Qualifications and competencies of the candidate	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
3) language certificate above B2	2

3. The candidate's scientific achievements are assessed by the team referred to in § 2 section 7 of the Recruitment Rules and award ranking points according to the following rules:

Candidate's scientific achievements	Number of Ranking Points
1) Documented scientific publications	0 ÷ 30
2) documented awards or scholarships of the Ministry of Science and Higher Education, Rector's awards or scholarships, distinctions for the best diploma thesis, other awards or recognitions for research activities	0 ÷ 10
3) documented achievements in the Students' Scientific Club (KNS)	0 ÷ 5
4) documented participation in research projects	0 ÷ 15

Note: the *number of ranking points for the criterion of scientific achievement of the candidate is the sum of the points awarded for the four elements of this criterion; in the event that this sum is greater than 30 points, the candidate is awarded* ***30 points.***

1) for documented scientific publications in a selected scientific discipline according to the following rules – **max. 30 points:**
   a. monograph in a scientific discipline – up to 15 points;
   b. a chapter in a multi-author monograph – up to 5 points;
   c. scientific publication in journals from the list of journals of the Ministry of Science and Higher Education – up to 10 points;
   d. scientific publication in journals outside the list of journals of the Ministry of Science and Higher Education – up to 5 points;
   e. participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials – up to 5 points;

2) for documented awards and scholarships of the Ministry of Science and Higher Education, Rector's awards and scholarships, other awards and recognitions for research activities according to the following rules – **max. 10 points:**
   a. obtaining an award or scholarship from the Ministry of Science and Higher Education – up to 5 points;
   b. obtaining an award or scholarship from the rector of the university – up to 3 points;
   c. distinction for the best diploma thesis – up to 2 points

3) for documented achievements in the KNS, the recruitment committee awards points according to the following rules – **max. 5 points:**
   a. distinction in the competition for the best student work within the activities of the KNS - up to 3 points;

b. distinction for speaking at the KNS seminar - up to 2 points.

4) on the basis of the statements of the principals of research projects on the candidate's participation in these projects – **max. 15 points.**

4. The interview is conducted by the Team referred to in § 2 section 7 of the Recruitment Rules and awards ranking points according to the following rules:

Interview	Number of Ranking Points
1) motivation to conduct research work, including obtaining initial approval of a potential supervisor	0 ÷ 15
2) presentation of the candidate's own interests and scientific achievements	0 ÷ 10
3) ability to conduct a scientific discussion	0 ÷ 5
4) general knowledge of the scientific discipline	0 ÷ 10

5. In the case of beneficiaries of the "Diamond Grant" programme and candidates referred to in § 1 section 3 of the Recruitment Rules, for whom the team referred to in § 2 section 7 of the Recruitment Rules decided that the candidate's scientific achievements are related to the scientific discipline referred to in § 1 section 1 of the Recruitment Rules, 60 points are awarded.

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

PROFESSIONAL QUESTIONNAIRE

surname..... name.....

1. Master's degree

a) University Name:

.....

b) Completed field of study: .....

c) Result of completing master's studies: .....

d) No., date and place of issue of the diploma: .....

e) Master's thesis title:.....

.....

.....

f) title, academic degree, name and surname of the supervisor of the master's thesis (supervisor)

.....

2. Do you have a doctoral degree? If so, please let me know when and where it was obtained and in which scientific discipline.

.....

3. Have you had or have you initiated a doctoral dissertation? If so, please indicate where and in which scientific discipline:

.....

4. Professional career in the last three years:

Period	Name of the workplace	Locality	Position

5. Please list foreign trips (e.g. Erasmus), internships, individual studies - referred to in Appendix 2 point 2 item 1.

……

……

……

6. Please list the certificates and certificates proving the acquisition of qualifications needed for scientific work - referred to in Appendix No. 2 point 2 item 2.

……

……

……

7. Please list the certificate of foreign language proficiency above the B2 level, referred to in Appendix No. 2 point 2 item 3.

……

……

……

....

city, date signature of the candidate

<u>Attachments</u>

- documents certifying qualifications and professional achievements from points 2 and 5-7

1. ..... (original/copy)*
2. ..... (original/copy)*
3. ..... (original/copy)*
4. ..... (original/copy)*
5. ..... (original/copy)*

** delete unnecessary*

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

SCIENTIFIC QUESTIONNAIRE

surname..... name.....

1. Please list scientific publications in the selected scientific discipline in accordance with Appendix No. 2 point 3 item 1

a) Monograph in a scientific discipline

……

……

……

b) chapter in a multi-author monograph

……

……

……

c) scientific publication in journals from the list of scientific journals of the Ministry of Science and Higher Education

……

……

……

d) scientific publication in journals outside the list of scientific journals of the Ministry of Science and Higher Education

……

……

……

e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials

……

……

……

……

……

2. Please list the awards or scholarships received in accordance with Appendix No. 2 point 3 item 2

a) Award or scholarship of the Ministry of Science and Higher Education:

……

……

b) Obtaining an award or scholarship from the Rector of the University:

……

……

c) Distinction for the best diploma thesis:

……

……

3. Please list your achievements in the Students' Scientific Club (KNS) in accordance with Appendix No. 2 point 3 item 3

a) distinction in the competition for the best student work within the activities of the KNS

……

……

b) distinction for speaking at the KNS seminar

……

……

4. List the research projects in which you have participated in the last 5 years:

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title, degree, name and surname Manager Project	% of project participation

5. Please provide the name of a person who can give an opinion on your predispositions for scientific work

.....
title, degree, name, surname, place of work and email address

6. Please indicate your preferred research topic within the selected scientific discipline

……

……

……

7. Please provide the title, academic degree, name and place of work of the person who has initially agreed to act as a supervisor:

……

……

……

……

……

....
city, date signature of the candidate

<u>Attachments</u>

- documents confirming the achievements referred to in points 1-4

1. ..... (original/copy)*
2. ..... (original/copy)*
3. ..... (original/copy)*
4. ..... (original/copy)*
5. ..... (original/copy)*

** delete unnecessary*

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018 on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit for the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Resolution
Senate of the Military University of Technology
Jarosław Dąbrowski

No. 9/WAT/2021 of 25 February 2021

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
Jarosław Dąbrowski for the academic year 2021/2022

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended), in connection with § 21(1)(27) of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019) The following is resolved:

§ 1

The "Rules of Recruitment to the Doctoral School of the Military University of Technology for the academic year 2021/2022" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

/--/ Col. Prof. Przemysław Wachulak

Attachment
to Resolution No. 9/WAT/2021 of the Senate of the Military University of Technology
of 25 February 2021

Rules of recruitment
to the Doctoral School of the Military University of Technology Jarosław Dąbrowski for the academic year 2021/2022

Section I
General

§ 1

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2021/2022, in the following scientific disciplines:
   1) automation, electronics and electrical engineering;
   2) technical informatics and telecommunications;
   3) civil engineering and transportation;
   4) materials engineering;
   5) mechanical engineering;
   6) safety sciences;
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School is carried out by means of a competition in accordance with these Rules of Recruitment to the Doctoral School of the Military University of Technology for the academic year 2021/2022, hereinafter referred to as the "Recruitment Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines, within the framework of which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as those applicable to Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for directing professional soldiers to the Doctoral School in the official mode are regulated by the provisions of the Act of 11 September 2003 on military service of professional soldiers (i.e. Journal of Laws of 2020, item 860, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places for the Doctoral School is set by the Rector by 31 May 2021 at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2021, the Scientific Discipline Councils will establish lists of potential supervisors along with research topics and immediately forward them to the Director for publication on the Doctoral School's website.

10. At the request of the Chairperson of the Council of Scientific Discipline, the Director may make changes to the list referred to in paragraph 9 by 31 July 2021.

Section II
Recruitment committee and qualification teams

§ 2

1. To conduct the recruitment procedure for the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Doctoral School's Admissions Committee, hereinafter referred to as the "Admissions Committee";
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "qualification team".
2. The Admission Committee and qualification teams are appointed by the Rector for the period from 16 March 2021 to 15 March 2022.
3. You are entitled to remuneration for your work in the recruitment committee and in the qualification team. In the decision referred to in paragraph 1, the Rector shall specify the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The recruitment committee consists of:
   1) chairman – director;
   2) one representative of the scientific discipline referred to in § 1 section 1;
   3) other persons reported by the Director;
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall, by 5 March 2021, submit to the Director the data of the representatives referred to in paragraph 1 point 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline.
3. At the request of the Chairperson of the Recruitment Committee, the Rector may appoint new members or dismiss already appointed members of the Recruitment Committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
7. Meetings of the committee may be held remotely. Decisions on the form of the meeting are made by the President.
8. The meetings of the recruitment committee are recorded. The minutes are signed by the Chairman and other members of the committee participating in the meeting.
9. The Recruitment Committee makes decisions in the form of resolutions. Resolutions are adopted by a simple majority of votes in an open vote, in the

presence of at least half of the members of the committee. In the event of an equal number of votes, the chairman's vote is decisive.

10. In the absence of the chairperson, the meeting of the committee shall be convened and chaired by a member of the committee authorised by the chairperson.
11. Tasks of the Recruitment Committee:
    1) supervision over the course of the recruitment procedure;
    2) preparing and submitting to the qualification teams a template of the protocol and individual candidate assessment sheets for the qualification teams;
    3) preparation of candidate documents for qualification teams;
    4) setting the dates of interviews within individual scientific disciplines;
    5) setting individual interview dates and notifying candidates;
    6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified to be entered on the list of doctoral students;
    7) publishing on the website of the Doctoral School a list of persons pre-qualified and, after verifying the declarations referred to in § 14 section 1, a list of persons admitted to the Doctoral School within individual scientific disciplines;
    8) preparation of decisions on refusal of admission to the Doctoral School.

§ 4

1. The qualification team of a scientific discipline includes:
    1) chairman;
    2) at least two members;
    3) secretary.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director by 5 March 2021 the data of candidates for:
    1) the chairperson and members of the team - from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline;
    2) secretary - from among the employees of the department related to the scientific discipline competent for the Council.
3. Tasks of qualification teams:
    1) analysis of candidates' documents provided by the recruitment committee;
    2) assessment of the compliance of the Master's degree programme completed by the candidate with the list of fields of study specified in Appendix No. 1 to the Recruitment Rules or an analysis of the candidates' scientific achievements referred to in § 6 section 2;
    3) analysis of qualifications, competences and scientific achievements of candidates and awarding ranking points in accordance with point 2 points 1-3 of Annex 3 to the recruitment rules;
    4) conducting an interview and awarding ranking points in accordance with point 2 point 4 of Appendix No. 3 to the Recruitment Rules,

5) determining the general, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 3 to the Recruitment Rules;
6) submission of the protocol to the Recruitment Committee together with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:
   a) pre-qualification of candidates for inclusion on the list of doctoral students;
   b) a proposal to change the limit of places for a scientific discipline;
   c) establishing a reserve list;
7) preparing information for the Recruitment Committee on the course of the selection procedure in the event of a candidate's request for reconsideration of the case.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairperson of the qualification team of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School.
3. A member of the qualification team is subject to exclusion from the assessment of the candidate, in particular if:
   1) has provided the candidate with the statement referred to in § 6 section 1 point 4;
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.
4. The Chairperson may exclude himself from the assessment of the candidate in the casesreferred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate shall be recorded in the protocol of the qualification team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 if they are:

1) hold the professional title of master's, master's degree in engineering or equivalent;
2) are graduates of fields of study providing second-cycle qualifications, hereinafter referred to as "master's studies", subject to paragraph 4, a detailed list of fields of study is contained in Appendix No. 1 to the Admission Rules;
3) meet the requirements set out in Article 186(1)(2) of the Act in terms of knowledge of a modern foreign language at the level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR);
4) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.

2. In exceptional cases, justified by the highest quality of scientific achievements, graduates of first-cycle studies or students who have completed the third year of long-cycle Master's studies meeting the requirements referred to in paragraph 1(3) and (4) may apply for admission to the Doctoral School.
3. In the absence of a master's degree due to waiting for its issuance, the candidate is obliged to present a certificate from the university on obtaining a master's degree.
4. In the case of a person holding a diploma of completion of a master's degree programme other than that listed in Appendix 1 to the rules of recruitment or studies completed outside Polish, the qualification team competent for the scientific discipline selected by the candidate decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline. The qualification team may ask the candidate to provide additional documents.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at the B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of a foreign language at the B2 level, they demonstrate knowledge of Polish, i.e.:
   1) complete a one-year preparatory course for taking up education in Polish in units designated by the minister competent for higher education, or
   2) have a certificate of knowledge of the Polish language issued by the State Commission for the Certification of Knowledge of Polish as a Foreign Language, or
   3) have completed their studies in Poland in a field of study conducted in Polish, or
   4) During the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:

1) registration of the candidate in the Internet Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee **– 9-22 August 2021;**
2) Qualification procedure – **23 August – 7 September 2021,** including:
   a) interviews – **30 August – 3 September 2021;**
3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 9 September 2021**;
4) issuance of an administrative decision on refusal to admit to the Doctoral School to candidates not qualified to be entered on the list of doctoral students **– 13-17 September 2021**;
5) submission by candidates pre-qualified to be entered on the list of doctoral students of the statement referred to in § 14 section 1 - **9-17 September 2021;**
6) announcement of the list of those admitted to the Doctoral School **- 22 September 2021**

2. The Recruitment Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the website of the Doctoral School by 15 July 2021.
3. The lists of candidates and admitted candidates referred to in paragraph 1 points 3 and 6 are published on the website of the Doctoral School.

Chapter III
Registration and documents to be filed

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) to familiarize yourself with these recruitment rules;
   2) preparing electronic versions of the documents referred to in paragraph 4;
   3) selecting a potential supervisor and the proposed research topic from the list referred to in § 1 section 9, conducting an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtaining a statement - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. Registration of candidates for the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the website of the Doctoral School and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to paragraphs 5 and 6:
   1) an application for admission to the Doctoral School generated from the IRK system and signed;
   2) a diploma confirming the obtaining of a master's degree, a master's degree in engineering or an equivalent degree;
   3) a supplement to the Master's degree or other document confirming the course of studies;
   4) a statement of a potential supervisor – according to the template contained in Appendix No. 2 to the Recruitment Rules;

5) a signed information questionnaire with attachments - according to the template contained in Appendix No. 4 to the Recruitment Rules;
6) curriculum vitae (CV);
7) a signed information clause concerning the processing of personal data – according to the template contained in Appendix No. 5 to the Recruitment Rules.

5. Candidates, beneficiaries of the "Diamond Grant" programme, in addition to the documents
referred to in paragraph 4, submit a document confirming that they have obtained the "Diamond Grant".
6. Candidates referred to in § 6 section 2 shall submit:
1) Documents referred to in paragraph 4 points 1 and 4-7;
2) a diploma confirming the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies;
3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act apply to the recognition of a diploma as entitling to undertake education at the Doctoral School.
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the Recruitment Committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.

Chapter IV
Enrolment fee

§ 9

1. The admission fee to the Doctoral School is PLN 200.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **August 22, 2021.**
3. In a particularly justified case, the candidate may, by 13 August 2021, submit an application to the Rector for exemption from the recruitment fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
4. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.
5. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 3 or the expiry of the deadline referred to in paragraph 4, the candidate shall not be subject to the qualification procedure.
6. The candidate is entitled – at his/her request – to a refund of the recruitment fee in the event of:
1) resignation from participation in the selection procedure before its commencement, i.e. before 23 August 2021;

2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by a qualification team appropriate for the scientific discipline selected by the candidate and includes:
   1) an analysis of the compliance of the Master's degree programme completed by the candidate with the list of fields of study included in Appendix No. 1 to the Admission Rules or, in the case of candidates referred to in § 6 section 2, an assessment of the quality of the candidate's scientific achievements and the relationship with one of the scientific disciplines indicated in § 1 section 1;
   2) awarding ranking points in the following criteria:
      a) the result of completing master's studies;
      b) qualifications and competences for education at the Doctoral School;
      c) scientific achievements;
      d) Interview.
2. The qualification team awards candidates with ranking points in individual criteria on the terms set out in Appendix 3 to the Recruitment Rules.
3. The qualification team, in the scope of the tasks specified in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee.
4. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c.
5. In the case of a beneficiary of the Diamond Grant programme, the qualification team shall award the candidate 60 points for the criteria referred to in paragraph 1(2)(a-c), irrespective of the candidate's results in those criteria.
6. The number of ranking points of the candidate for the criterion referred to in paragraph 1 point 2 letters b-d shall be the arithmetic average of the points awarded by the individual members of the qualification team, rounded up to one decimal place, and may not be greater than the maximum value specified for the criterion in question.
7. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 100 points.
8. After the completion of the selection procedure, the qualification team shall immediately submit to the recruitment committee the completed and signed documents referred to in § 3 section 11 point 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and his/her scientific interests

based on the presented research project and general knowledge of the scientific discipline.

2. Information on the date and place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 is provided to candidates electronically to the e-mail address indicated in the IRK system and is published on the website of the Doctoral School by 25 August 2021.
3. The interview can be conducted remotely using commonly available online tools.
4. Before the interview begins, the chair or secretary of the selection team is obliged to verify the identity of the candidate.
5. The interview consists of two parts:
    1) The first part – presentation by the candidate of a preliminary research project prepared in accordance with the research topic agreed with the potential supervisor – max. 10 min.;
    2) The second part – questions from the members of the qualification team aimed at checking the candidate's general knowledge in the field of the selected scientific discipline, the ability to justify/defend the presented research project, conduct a scientific discussion and motivation for research work.
6. The initial research project should include m.in:
    1) defining the research problem (objective, research questions, hypotheses);
    2) the proposed methodology;
    3) the state of research in the scope of the proposed project topic;
    4) reference to literature related to the subject of the project.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the Admission Committee may order the Qualification Team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only if he/she meets the formal requirements referred to in § 6 section 1, pays the recruitment fee in accordance with the conditions specified in § 9, receives a positive grade referred to in § 10 section 3 and obtains a total of at least 50 ranking points, including: at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 shall prevent the candidate from being entered on the ranking list of candidates even if the limit of places for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee prepares a protocol on the recruitment process, to which a document called the ranking list of candidates is attached, containing information about the candidates pre-qualified for entry on the list of doctoral students.

3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) the interview referred to in § 10 section 1 point 2 letter d;
   2) scientific achievements referred to in § 10 section 1 point 2 letter c;
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admissions committee.
6. In the case referred to in paragraph 5, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2021/2022.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) names and surnames of candidates;
   2) the number of ranking points awarded for the criteria referred to in point 1 of Appendix 3 to the Recruitment Rules;
   3) final result – the sum of the ranking points;
   4) indicate whether the candidate has been pre-qualified to be entered on the list of doctoral students of the Doctoral School.
9. The protocol is signed by the members of the recruitment committee who took part in the recruitment procedure, and the ranking list is signed by the chairperson of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the recruitment committee.

Chapter VII
Admission and Refusal of Admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after submitting a statement to the Dean's Office of the Doctoral School in paper form or sending it in electronic form (email: szkola.doktorska@wat.edu.pl) no later than by 17 September 2021 in accordance with the template specified in Appendix 6 to the Recruitment Rules.
2. Failure to meet the requirement specified in paragraph 1 results in the candidate being removed from the list of pre-qualified candidates for entry on the list of doctoral students and the admissions committee applying to the Rector for a decision on refusal of admission to the Doctoral School.
3. Candidates who have not been accepted due to the exhaustion of the limit of places constitute a reserve group. In the event of vacancies on the list of pre-qualified candidates for the Doctoral School for the academic year 2021/2022, these persons may, by the decision of the recruitment committee, be admitted to the Doctoral School in the order resulting from the number of points obtained.

4. The admissions committee immediately informs the candidate of admission in this manner. The provisions of paragraphs 1 and 2 shall apply accordingly, whereby the candidate is obliged to submit the declaration referred to in paragraph 1 within seven days from the date of providing information about this obligation, failing which the qualification will expire by law.

§ 15

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Special recruitment procedures for the WAT Doctoral School are conducted by the recruitment committee and qualification teams referred to in § 2 section 1 as separate competition procedures, outside the limits of places specified in § 1 section 8.
2. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activities of the admissions committee and qualification teams during a special recruitment procedure, the Rector may extend their activity until the end of this procedure.
3. Candidates recruited to the Doctoral School as part of a special recruitment procedure must meet both the formal criteria referred to in § 6 section 1 and the criteria specified for the programme, project, grant or agreement.
4. Candidates referred to in paragraph 3 may be admitted to the Doctoral School for the academic year 2021/2022 only on condition that they ensure, throughout the entire period of education, full funding from doctoral scholarship programmes, projects, grants or agreements in the amount of not less than the amount of the scholarship specified in Article 209(4) of the Act and a possible increase in the scholarship and co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.
5. The period of education referred to in paragraph 4 also includes the period of suspension of education and extension of the deadline for submitting a doctoral dissertation.
6. The condition for admission to the Doctoral School and the financing of the candidates referred to in paragraph 5 is an agreement specifying the conditions for the implementation, financing and settlement of financial resources for the financing of the scholarship or doctoral scholarships, the increase in the

amount of the scholarship or scholarships and the costs of social security incurred by WAT and, if applicable, the co-financing of the costs of using the research infrastructure, as well as the financing of activities related to the procedure
for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. The recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Science and Higher Education of 29 May 2019 on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for the implementation recruitment should be recruited primarily from among the employees of enterprises and other entities cooperating with the Military Academy.
3. By 31 March 2021, the Recruitment Committee determines:
   1) the schedule for conducting the implementation recruitment;
   2) a list and templates of documents submitted by a potential supervisor and candidate at each stage of recruitment;
   3) templates of protocols, research project evaluation cards and individual candidate evaluation cards for qualification teams;
   4) the manner and place or form of submission of documents.
4. Implementation recruitment is carried out by the recruitment committee and qualification teams in two stages:
   1) preliminary stage;
   2) final stage.
5. The initial stage includes:
   1) submission of documents by the candidate and potential supervisor;
   2) the Recruitment Committee submits documents to the competent qualification team for the scientific discipline;
   3) assessment by the qualifying team of the submitted research project;
   4) preliminary qualification procedure conducted by the qualification team, in the scope of:
      a) meeting the candidate's formal requirements for:
         - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'CC programme';
         - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 point 1;
      b) conduct an interview;
      c) awarding ranking points for the criteria referred to in §10 section 1 point 2;

d) provide the admissions committee with the documents referred to in paragraph 3(3) together with recommendations to the admissions committee regarding the qualification of the research project and the candidate for the DW programme.

6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in paragraph 5 point 4 letter a and obtain a minimum of 20 points from the interview.
7. Before accepting the protocols of the qualification teams, the admissions committee may commission the qualifying team to re-evaluate the research project or to analyze the documents and the method of awarding ranking points. This does not apply to points awarded for an interview.
8. The admissions committee prepares a protocol from the course of the preliminary stage, to which, in the case of positive acceptance of the project and candidates, it attaches a document called the ranking list of candidates, containing information about candidates pre-qualified for entry on the list of doctoral students under the DW program.
9. On the basis of the protocol of the recruitment committee from the preliminary stage:
   1) an application is submitted through the Integrated System of Services for Science Service of Funding Streams (ZSUN/OSF) to the minister responsible for higher education and science, hereinafter referred to as the "Minister",
   for the qualification of WAT for participation in the DW programme, or
   2) in the event of a negative assessment of the research project or a negative assessment of the candidate, the candidate receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2021/2022 as part of the programme.
10. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is placed on the website of the Doctoral School and sent to the candidate's e-mail address.
11. The final stage applies only to candidates who have been entered on the ranking list in the initial stage and includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee - within the deadline specified in § 7 section 1 point 1;
   2) the candidate provides documents for this stage, specified in paragraph 3 point 2;
   3) conducting the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 13;
   4) preparation of the final protocol from the implementation recruitment by the recruitment committee.
12. The admissions committee may, at any stage of the induction recruitment, call upon the candidate to submit additional documents confirming that they meet the requirements for participation in the DW program.
13. The final qualification is carried out only if the Minister provides information on the qualification of the WAT proposal for participation in the DW programme, together with information on the number of doctoral students who can be admitted to the Doctoral School under this programme in individual scientific

disciplines for the academic year 2021/2022 and the amount of financial resources broken down by academic years.

14. If the Minister provides information on the non-qualification of the WAT application for participation in the DW programme, the Rector issues a decision refusing to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
15. As a result of the final qualification, on the basis of the final protocol of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2021/2022 as part of the DW program, or
    2) receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2021/2022 under this programme.
16. Participation of a candidate in the induction recruitment does not exclude, at his/her request, participation in the recruitment to the Doctoral School for the academic year 2021/2022.

Chapter III
Other programs, projects, grants, agreements

§ 18

1. Special recruitment procedures may also be conducted under other programs, projects, grants or contracts.
2. The detailed rules of the procedures referred to in paragraph 1 shall be determined by the recruitment committee, at least 14 days before the start of the recruitment process, taking into account the candidates' fulfilment of the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or contract.
3. Selection procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions shall apply:
    1) Act;
    2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the recognition of diplomas of completion of studies abroad and confirmation of completion of studies at a certain level (Journal of Laws of 28 September 2018).item 1881);
    3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2020, item 256, as amended).

Appendix no. 1 to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

List of fields of study whose graduates may apply for admission to the Doctoral School

Scientific discipline conducted at the Doctoral School	Completed Master's degree
Automation, Electronics and Electrical Engineering	- Automation and robotics - electronics - Electronics & Telecommunications - electrical engineering - Energy - physics - Technical physics - Photonics - Materials Engineering - Mechatronics - computer science - Biomedical Engineering - Optoelectronics and Photonics - Aerospace and Satellite Engineering - nanotechnology - Optical Engineering
Technical Informatics and Telecommunications	- Automation and robotics - Electronics & Telecommunications - electrical engineering - computer science - Computer Science and Econometrics
Civil Engineer & Transportation	- Construction - Geodesy and Cartography - geophysics - geography - geology - physics - computer science - navigation - mathematics - Aerospace and Satellite Engineering
Materials Engineering	- chemistry - physics - Technical physics - chemical and process engineering - Materials Engineering - Production Engineering - mechanics and mechanical engineering - metallurgy - Chemical Technology
Mechanical Engineering	- Materials Engineering - logistics - mechanics and mechanical engineering - Mechatronics - transport - Production Management and Engineering - Automation and robotics - Technical physics - Aerospace
Chemical Sciences	- chemistry - Chemical Technology - chemical and process engineering - biotechnology - Materials Engineering - biochemistry - environmental protection - Environmental Engineering - physics
Security Sciences	- National security - internal security - European Studies - Safety Engineering - logistics - political science - international relations - management - National defence - State security management

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

……..
(degree)

……..
(name and surname of the potential supervisor)

……..
(scientific discipline represented)

……..
(Faculty)

STATEMENT

I declare that in the event of your admission:

.....
(name and surname of the candidate)

to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2021/2022, I hereby give preliminary consent to scientific supervision and acting as a supervisor within the research topics:

……
……
……
……
……
(research topics)

……. ……..
(date) *(signature of a potential supervisor)*

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

Detailed rules awarding ranking points to candidates

1. Qualification teams of individual scientific disciplines award candidates with ranking points according to criteria.

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in § 10 section 4 and 5 of the recruitment rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Interview	0 ÷ 40	0÷ 40
Total max.	**100**	

2. Detailed rules for awarding ranking points in individual criteria:
   1) The result of completing a master's degree.

Result	Number of points Ranked
5w	20
5	15
4+	10
4	5
less than 4	0

   2) Qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline.

Specification	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
3) certificate of foreign language proficiency above B2	2

   3) Scientific achievements of the candidate.

Specification	Number of Ranking Points
1) documented scientific publications published in the last 5 years, including:	**0 ÷ 30 points**
a) monograph	0 ÷ 15 pts for one monograph
b) chapter in a multi-author monograph	0 ÷ 5 pts per chapter – no more than 10 points in total
c) scientific publication in journals from the list of journals referred to in Article 267(2) of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list of journals referred to in point c	0 ÷ 5 pts for one publication – a total of no more than 15 points.
e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials	0 ÷ 5 pts for one publication – a total of no more than 10 points.
2) Documented awards or scholarships	**0 ÷ 15 pts**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one prize or scholarship
b) obtaining a Rector's Award or Scholarship	0 ÷ 3 points
c) Distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 pts**
a) distinction in the competition for the best student work within the activities of the KNS	0 ÷ 3 points;
b) distinction for speaking at the KNS seminar	0 ÷ 2 pts.
4) documented participation in research projects - based on statements made by research project managers	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF formats*
2. *In the event that the sum of points from the sub-criteria exceeds the maximum value for this criterion, the candidate is awarded the maximum number of points for this criterion*

4) Interview.

Specification	Number of Ranking Points
1) evaluation of the presented research project in the scope of: a) defining the research problem (goal, research questions, hypotheses), b) the proposed methodology, c) innovativeness and originality of the issues undertaken, d) presentation of the state of research in the field of design and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend your project, b) general knowledge in the field of scientific discipline, c) the ability to conduct scientific discussions, including consistency and transparency of argumentation, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

INFORMATION QUESTIONNAIRE

surname..... name.....

I. MASTER DATA

1. Completed second-cycle studies (master's)

a) University Name: .....

b) Completed field of study: .....

c) Result of completing master's studies: .....

d) No., date and place of issue of the diploma: .....

e) Title of diploma thesis: .....

.....

.....

f) title/academic degree, name and surname of the thesis supervisor

.....

2. Do you have a doctoral degree? If so, please attach a copy of your doctoral diploma or temporary certificate – *attachment no. 1*

3. Have you had or have you initiated a doctoral dissertation? If so, please indicate where and in which scientific discipline and the subject of the dissertation.

.....

.....

4. Current employment

.....

.....

(name of the workplace, town, position held)

II. QUALIFICATIONS AND COMPETENCES

1. Trips abroad and individual studies:

a) mobility within the framework of programs, e.g. Erasmus – *attachment no. 2*

.....

.....
(name of the programme, date of departure, semester of study, host university, country)

b) **Foreign internships – *Appendix No. 3***

.....
(name of traineeship, date, semester of study, host institution, country)

.....
(name of traineeship, date, semester of study, host institution, country)

c) **Individual studies - *attachment no. 4***

.....
(semester(s) of study, level of study)

.....
(semester(s) of study, level of study)

2. Certificates and certificates proving the acquisition of qualifications needed for scientific work - *Appendix No. 5*

.....
(name of certificate/attestation)

.....
(name of certificate/attestation)

.....
(name of certificate/attestation)

3. Document certifying knowledge of a foreign language at the level of language proficiency at least B2 - *attachment no. 6*[1]

.....
(name of the certificate/attestation, supplement to the first-cycle diploma)

4. Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Annex No. 7*[2]

.....
(document name)

---

[1] in the case of:
- certificate above B2, only this certificate should be attached,

[2] documents referred to in § 6 section 6 points 1-3

III. SCIENTIFIC ACHIEVEMENTS

1. Publication activity in the scientific discipline <u>in the last 5 years</u>[3]:

a) Monograph in the scientific discipline - ***<u>Appendix No. 8</u>***

……
(title, publisher, year of publication)

……
(title, publisher, year of publication)

b) Chapter in the multi-author monograph - ***<u>Appendix No. 9</u>***

……
(title, monograph title, publisher, year of publication)

……
(title, monograph title, publisher, year of publication)

……
(title, monograph title, publisher, year of publication)

c) scientific publication in journals from the list of scientific journals referred to in Article 267(2) of the Act - ***<u>Annex No. 10</u>***

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

d) scientific publication in journals outside the list of scientific journals referred to in Article 267(2) of the Act **- *<u>Annex No. 11</u>***

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

[3] in the case of:
- monograph should be accompanied by a copy of the title page and an abstract (max. 5 pages). A4),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, the title page and the abstract (max. 3 pages). A4), a copy of the entire publication should be attached to 5 pages,

e) participation in a scientific conference with a presentation of the paper and its publication in peer-reviewed post-conference materials - ***attachment no. 12***

……
(name of the conference, date, place, topic of the presentation)

……
(name of the conference, date, place, topic of the presentation)

……
(name of the conference, date, place, topic of the presentation)

2. Awards, scholarships

a) awards or scholarships of the minister competent for higher education and science or the Minister of National Defence – ***attachment no. 13***

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

b) obtaining the Rector's award or scholarship – ***attachment no. 14***

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

c) Distinction for the best diploma thesis – ***attachment no. 15***

……
(engineering/bachelor's/master's thesis, date of award)

……
(engineering/bachelor's/master's thesis, date of award)

d) Other awards for research activities – ***Appendix No. 16***

……
(award title, date of award)

……
(award title, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

a) distinction in the competition for the best student work within the activities of the KNS – ***attachment no. 17***

……

……

……

(the topic of the work, the date of awarding the distinction)

b) distinction for speaking at the KNS seminar – ***attachment no. 18***

……

……

……

……

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title, degree, name and surname Manager Project	% of project participation

Comments:

- only attachments in pdf format are uploaded to the IRK system,
- the annex to the point/sub-point of the Questionnaire should contain a confirmation of all the information indicated in that point/sub-point,
- attachments should contain confirmations of awards, scholarships, distinctions obtained in the form of scans of diplomas, certificates, decisions,
- the candidate's participation in research projects is confirmed by a certificate from the principal investigator,
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

....

city, date signature of the candidate

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018. Law on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit and be admitted to the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and , subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Appendix No. 6
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I hereby declare that as of **1 October 2021.**:

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology will be the only doctoral school where I will start my education;
2. I will not be employed as an academic or researcher;
3. I will/will not* be employed as an academic teacher or researcher under the conditions set out in Article 209(10)(1) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended);
4. I have/do not have* a doctoral degree;
5. I have/do not have* the certificate(s):
   1) about disability*,
   2) the degree of disability*, referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2018, item 511);

……..
legible signature

Attachments:

……
……
**- delete unnecessary*

Remark:

In the cases referred to in:

- *point 3 - information on the candidate's employment for the purpose of carrying out the research project referred to in Article 119(2)(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended) should be attached),*
- *point 4 – a copy of the diploma conferring the academic degree of a doctor should be attached,*
- *point 5 – a copy of the decision should be attached.*

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 11/WAT/2022 of 24 February 2022

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended), in connection with § 21(1)(27) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021) The following is resolved:

§ 1

The "Rules of Recruitment to the Military University of Technology Doctoral School for the academic year 2022/2023" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

(-) Col. Prof. Przemysław Wachulak

Attachment
to Resolution No. ..../WAT/2022 of the WAT Senate
of 2022

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2022/2023

Section I
General

§ 1

1. The Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2022/2023, in the following scientific disciplines:
   1) automation, electronics and electrical engineering,
   2) technical informatics and telecommunications,
   3) civil engineering and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) safety sciences,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School is carried out by means of a competition in accordance with these Rules of Admission to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2022/2023, hereinafter referred to as the "Admission Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines, within the framework of which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as those applicable to Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for directing professional soldiers to the Doctoral School in the official mode are regulated by the provisions of the Act of 11 September 2003 on the military service of professional soldiers (i.e. Journal of Laws of 2021, item 1131, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places for the Doctoral School is set by the Rector by 31 May 2022, at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2022, the Scientific Discipline Councils will establish lists of potential supervisors along with research topics and immediately forward them to the Director for publication on the Doctoral School's website.

10. At the request of the Chairman of the Council of Scientific Discipline , the Director may make changes to the list referred to in paragraph 9 by 31 July 2022

Section II
Recruitment committee and qualification teams

§ 2

1. To conduct the recruitment procedure for the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Doctoral School's Admissions Committee, hereinafter referred to as the "Admissions Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "qualification team".
2. The Admission Committee and qualification teams are appointed by the Rector for the period from 16 March 2022 to 15 March 2023.
3. You are entitled to remuneration for your work in the recruitment committee and in the qualification team. In the decision referred to in paragraph 1, the Rector shall specify the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The recruitment committee consists of:
   1) chairman – director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the headteacher,
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. By 5 March 2022, the chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director the data of the representatives referred to in paragraph 1 point 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline.
3. At the request of the Chairperson of the Recruitment Committee, the Rector may appoint new or dismiss appointed members of the Recruitment Committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
7. Meetings of the committee may be held remotely. Decisions on the form of the meeting are made by the chairman of the recruitment committee.
8. The meetings of the recruitment committee are recorded. The minutes shall be signed by the chairperson of the recruitment committee and the members of the committee participating in the meeting, subject to paragraph 9.
9. In the case of a meeting of the committee conducted remotely, the minutes are signed only by the chairperson of the recruitment committee.
10. The Recruitment Committee makes decisions in the form of resolutions. Resolutions are adopted by a simple majority of votes in an open vote, in the

presence of at least half of the members of the committee. In the event of an equal number of votes, the vote of the chairman of the recruitment committee is decisive.

11. In the absence of the chairperson, the meeting of the committee shall be convened and chaired by a member of the committee authorised by the chairperson.
12. Tasks of the Recruitment Committee:
    1) supervision over the course of the recruitment procedure,
    2) preparing and submitting to the qualification teams a template of the protocol and individual candidate evaluation sheets for the qualification teams,
    3) preparation of candidate documents for qualification teams,
    4) setting the dates of interviews within individual scientific disciplines,
    5) setting individual interview dates and notifying candidates,
    6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified to be included in the list of doctoral students,
    7) publishing on the website of the Doctoral School a list of pre-qualified persons and, after verifying the declarations referred to in § 14 section 1, a list of those admitted to the Doctoral School within individual scientific disciplines,
    8) preparation of decisions on refusal of admission to the Doctoral School.

§ 4

1. The qualification team of a scientific discipline includes:
    1) chairman
    2) at least two members,
    3) secretary.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1, shall, by 5 March 2022, submit to the Director the data of candidates for:
    1) the chairperson and members of the team - from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline,
    2) secretary - from among the employees of the department related to the scientific discipline competent for the Council.
3. Tasks of qualification teams:
    1) analysis of candidates' documents submitted by the recruitment committee,
    2) analysis and assessment of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
    3) analysis of qualifications, competences and scientific achievements of candidates and awarding ranking points in accordance with point 2 points 1-3 of Annex No. 1 to the recruitment rules,
    4) analysis of the concept of the candidates' doctoral dissertation and awarding of ranking points in accordance with point 2 point 4 of Annex No. 1 to the recruitment rules,

5) conducting an interview and awarding ranking points in accordance with point 2 point 5 of Appendix No. 1 to the Recruitment Rules.
6) determining the total, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the Recruitment Rules,
7) submission of the protocol to the Recruitment Committee together with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:
   a) pre-qualification of candidates for inclusion on the list of doctoral students,
   b) a proposal to change the limit of places for a scientific discipline,
   c) establishing a reserve list,
8) preparing information for the Recruitment Committee on the course of the selection procedure in the event of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and members of the qualification team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairperson of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairperson of the qualification team of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School.
3. A member of the qualification team is subject to exclusion from the assessment of the candidate, in particular if:
   1) has provided the candidate with the statement referred to in § 6 section 1 point 3,
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.
4. The Chairperson may exclude himself from the assessment of the candidate in the cases referred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate shall be recorded in the protocol of the qualification team.

Section III
Recruitment procedure

Chapter I

Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 if they are:
   1) have a master's degree, a master's degree in engineering or an equivalent degree,
   2) have a documented knowledge of English at the level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 4 – the list of documents confirming knowledge of English at the level of at least B2 is contained in Appendix No. 5 to the Recruitment Rules
   3) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. In exceptional cases, justified by the highest quality of scientific achievements, graduates of first-cycle studies or students who have completed the third year of long-cycle master's studies meeting the requirements referred to in paragraph 1 points 2 and 3 may apply for admission to the Doctoral School.
3. In the absence of a master's degree due to waiting for its issuance, the candidate is obliged to present a certificate from the university on obtaining a master's degree.
4. A certificate is not required for native English speakers.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at the B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of Polish, i.e.:
   1) complete a one-year preparatory course for taking up education in Polish in units designated by the minister competent for higher education, or
   2) have a certificate of knowledge of the Polish language issued by the State Commission for the Certification of Knowledge of Polish as a Foreign Language, or
   3) have completed their studies in Poland in a field of study conducted in Polish, or
   4) During the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Internet Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee **– 1-14 August 2022,**
   2) Qualification procedure – **15 August – 2 September 2022,** including:
      a) interviews – **August 29 – September 2, 2022,**

3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 8 September 2022**,
4) issuance of an administrative decision on refusal to admit to the Doctoral School to candidates not qualified for inclusion on the list of doctoral students **– 12-15 September 2022**,
5) submission by candidates pre-qualified for inclusion on the list of doctoral students of the statement referred to in § 14 section 1 – **8-16 September 2022,**
6) announcement of the list of those admitted to the Doctoral School **- September 22, 2022**

2. The Recruitment Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2022.
3. The lists of candidates and admitted candidates referred to in paragraph 1 points 3 and 6 are published on the website of the Doctoral School.

Chapter III
Registration and documents to be filed

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) familiarize yourself with these recruitment rules,
   2) prepare electronic versions of the documents referred to in paragraph 4,
   3) selecting a potential supervisor and the proposed research topic from the list referred to in § 1 section 9, conducting an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtaining a statement - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. Registration of candidates for the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the website of the Doctoral School and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to paragraphs 5 and 6:
   1) an application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the obtaining of a master's degree, a master's degree in engineering or an equivalent degree,
   3) a diploma supplement or other document confirming the course of studies,
   4) a statement of a potential supervisor – according to the template contained in Appendix No. 2 to the Recruitment Rules,
   5) the concept of the doctoral dissertation – according to the template contained in Appendix No. 3 to the Recruitment Rules,
   6) a signed information questionnaire with attachments - according to the template contained in Appendix 4 to the Recruitment Rules,
   7) curriculum vitae (CV);

8) a signed information clause regarding the processing of personal data – according to the template contained in Appendix No. 6 to the Recruitment Rules.

5. Candidates, beneficiaries of the "Diamond Grant" programme, in addition to the documents
   referred to in paragraph 4, submit a document confirming that they have obtained the "Diamond Grant".
6. Candidates referred to in § 6 section 2 shall submit:
   1) documents referred to in paragraph 4 points 1 and 4-7,
   2) a diploma confirming the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies,
   3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act apply to the recognition of a diploma as entitling to undertake education at the Doctoral School.
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the Recruitment Committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.

Chapter IV
Enrolment fee

§ 9

1. The admission fee to the Doctoral School is PLN 200.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **August 15, 2022.**
3. In a particularly justified case, the candidate may, by 5 August 2022, submit an application to the Rector for exemption from the recruitment fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
4. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.
5. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 3 or the expiry of the deadline referred to in paragraph 4, the candidate shall not be subject to the qualification procedure.
6. The candidate is entitled – at his/her request – to a refund of the recruitment fee in the event of:
   1) resignation from participation in the qualification procedure before its commencement, i.e. before 15 August 2022;
   2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by a qualification team appropriate for the scientific discipline selected by the candidate and includes:
   1) analysis and evaluation of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
   2) awarding ranking points in the following criteria:
      a) the result of completing master's studies,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) the concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards candidates with ranking points in individual criteria on the terms set out in Appendix No. 1 to the Recruitment Rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the event of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside Polish, the qualification team competent for the scientific discipline selected by the candidate may ask the candidate to submit additional documents.
5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c.
6. In the case of a beneficiary of the Diamond Grant programme, the qualification team shall award the candidate 60 points for the criteria referred to in paragraph 1(2)(a-c), irrespective of the candidate's results in those criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b-e) shall be the arithmetic average of the points awarded by each member of the qualification team, rounded up to one decimal place, and shall not exceed the maximum value specified for the criterion in question.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the end of the selection procedure, the qualification team shall immediately submit to the recruitment committee the completed and signed documents referred to in § 3 section 12 point 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and his/her scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date and place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 is provided to candidates

electronically to the e-mail address indicated in the IRK system and is published on the website of the Doctoral School by 19 August 2022.

3. The interview can be conducted remotelyusing commonly available online tools. The preferred messenger is MS Teams.
4. Before the interview begins, the chair or secretary of the selection team is obliged to verify the identity of the candidate.
5. The interview consists of two parts:
    1) the first part – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) The second part – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the introductory topic of the doctoral dissertation,
    2) justification for the choice of topic, results of the analysis of the state of knowledge in the field of selected research issues, literature review,
    3) initial definition of the research problem (objective, research questions, hypotheses),
    4) the proposed methodology,
    5) expected results,

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the Admission Committee may order the Qualification Team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the case of:
    1) meeting the formal requirements referred to in § 6 section 1,
    2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
    3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
    4) obtaining a total of at least 55 ranking points, including at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 shall prevent the candidate from being entered on the ranking list of candidates even if the limit of places for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee prepares a protocol on the recruitment process, to which a document called the ranking list of candidates is attached, containing

information about the candidates pre-qualified for entry on the list of doctoral students.

3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admissions committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2022/2023.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) names and surnames of candidates,
   2) the result of the assessment of the relationship between the Master's degree programme, other forms of education and scientific achievements completed by the candidate and the scientific discipline of his/her choice,
   3) the number of ranking points awarded for the criteria referred to in point 1 of Appendix 1 to the Recruitment Rules,
   4) final result – the sum of the ranking points,
   5) indicate whether the candidate has been pre-qualified to be entered on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the recruitment committee.

Chapter VII
Admission and Refusal of Admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after submitting a statement to the Dean's Office of the Doctoral School in paper form or sending it in electronic form (email: szkola.doktorska@wat.edu.pl) no later than by 17 September 2022 in accordance with the template specified in Appendix No. 7 to the Recruitment Rules.
2. Failure to meet the requirement specified in paragraph 1 results in the candidate being removed from the list of pre-qualified candidates for entry on the list of doctoral students and the admissions committee applying to the Rector for a decision on refusal of admission to the Doctoral School.
3. Candidates who have not been accepted due to the exhaustion of the limit of places constitute a reserve group. In the event of vacancies on the list of pre-

qualified candidates for the Doctoral School for the academic year 2022/2023, these persons may, by the decision of the recruitment committee, be admitted to the Doctoral School in the order resulting from the number of points obtained.

4. The admissions committee immediately informs the candidate of admission in this manner. The provisions of paragraphs 1 and 2 shall apply accordingly, whereby thecandidate is obliged to submit the declaration referred to in paragraph 1 within seven days from the date of providing information about this obligation, failing which the qualification will expire by law.

§ 15

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School under a special recruitment procedure takes place as a separate competition procedure, outside the limits of places specified in § 1 section 8, the rules of which take into account these recruitment rules and the rules specified for the programme, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. The common rules of recruitment are approved by the chairperson of the recruitment committee after agreement with the representatives of the competent institution or the manager of the programme, project, grant or contract
3. Special recruitment procedures for the Doctoral School may be conducted by the Admission Committee and the qualification teams referred to in § 2 section 1, subject to paragraphs 4 and 5.
4. The meetings of the selection teams and the selection committee as part of the special recruitment procedure may be attended by the representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred
   to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activities of the admissions committee and qualification teams during a special recruitment procedure, the Rector may extend their activity until the end of this procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2022/2023 only on condition that they ensure, throughout the entire period of education, full funding from doctoral scholarship programmes, projects, grants or agreements in the

amount of not less than the amount of the scholarship specified in Article 209(4) of the Act, and a possible increase in the scholarship and co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.

8. The period of education referred to in paragraph 6 also includes the period of suspension of education and extension of the deadline for submitting a doctoral dissertation.
9. The condition for admission to the Doctoral School and the financing of the candidates referred to in paragraph 6 is an agreement specifying the conditions for the implementation, financing and settlement of financial resources for the financing of the scholarship or doctoral scholarships, the increase in the amount of the scholarship or scholarships and the costs of social security incurred by the Military University of Technology and, if applicable, the co-financing of the costs of using the research infrastructure, as well as the financing of activities related to the procedure for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. The recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Education and Science of 16 April 2021 on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for the implementation recruitment should be recruited primarily from among the employees of enterprises and other entities cooperating with the Military Academy.
3. By 31 March 2022, the Recruitment Committee determines:
   1) schedule of implementation recruitment,
   2) a list and templates of documents submitted by a potential supervisor and candidate at each stage of recruitment,
   3) templates of protocols, evaluation cards for the concept of the doctoral dissertation, cards for the evaluation of scientific achievements of the potential supervisor in the field of the subject selected by the candidate and individual evaluation cards for qualification teams,
   4) the manner and place or form of submission of documents.
4. Implementation recruitment is carried out by the recruitment committee and qualification teams in two stages:
   1) preliminary stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee - within the deadline specifiedin the schedule referred to in paragraph 3 point 1,
   2) submission of documents by the recruitment committee to the qualification team competent for the scientific discipline,

3) analysis and evaluation by the qualification team of the submitted topic of the doctoral dissertation and the scientific achievements of the potential supervisor,
4) Qualification proceedings conducted by the qualification team, in the scope of:
   a) meeting the candidate's formal requirements for:
      - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'CC programme',
      - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 point 1,
   b) conducting an interview,
   c) awarding ranking points for the criteria referred to in §10 section 1 point 2,
   d) provide the admissions committee with the documents referred to in paragraph 3(3) together with recommendations to the admissions committee regarding the qualification of the research project and the candidate for the DW programme.

6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in paragraph 5(4)(a) and obtain a minimum of 20 points from the interview.
7. Before accepting the protocols of the qualification teams, the admissions committee may commission the qualifying team to re-evaluate the research project or to analyze the documents and the method of awarding ranking points. This does not apply to points awarded for an interview.
8. The admissions committee prepares a protocol from the course of the preliminary stage, to which, in the case of positive acceptance of the project and candidates, it attaches a document called the ranking list of candidates, containing informationabout candidates pre-qualified for entry on the list of doctoral students under the DW program.
9. On the basis of the protocol of the recruitment committee from the preliminary stage:
   1) is submitted, through the Integrated System of Services for Science Servicing Funding Streams (ZSUN/OSF), an application to the minister responsible for higher education and science, hereinafter referred to as the "Minister"
      , for the qualification of a candidate for participation in the DW programme, or
   2) in the event of a negative assessment of the research project or a negative assessment of the candidate, the Rector receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2022/2023 as part of the programme.
10. The applications referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.
11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is placed on the website of the Doctoral School and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the initial stage and includes:
   1) the candidate provides documents for this stage, specified in paragraph 3 point 2,

2) conducting the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 13,
3) preparation of the final protocol from the implementation recruitment by the recruitment committee.

13. The admissions committee may, at any stage of the induction recruitment, call upon the candidate to submit additional documents confirming that they meet the requirements for participation in the DW program.
14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application for participation in the DW programme, together with information on the number of doctoral students who may be admitted to the Doctoral School under this programme in individual scientific disciplines for the academic year 2022/2023 and the amount of financial resources broken down by academic years.
15. If the Minister provides information on the non-qualification of the WAT application for participation in the DW programme, the Rector issues a decision refusing to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final protocol of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2022/2023 as part of the DW program, or
    2) receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2022/2023 under this programme.
17. The candidate's participation in the induction recruitment does not exclude, at his or her request, participation in the recruitment to the Doctoral School for the academic year 2022/2023.

Chapter III
Other programs, projects, grants, agreements

§ 18

1. Special recruitment procedures may also be conducted under other programs, projects, grants or contracts.
2. The detailed rules of the procedures referred to in paragraph 1 shall be determined by the recruitment committee, at least 14 days before the start of the recruitment process, taking into account the candidates' fulfilment of the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or contract.
3. Selection procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions shall apply:
    1) Act
    2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the recognition of diplomas of completion of studies abroad and

confirmation of completion of studies at a certain level (Journal of Laws of 28 September 2018).item 1881),

3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2021, item 735, as amended).

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

Detailed rules awarding ranking points

1. Qualifying teams award ranking points to candidates according to the following criteria:

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in § 10 section 5 and 6 of the Recruitment Rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Doctoral dissertation concept	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. Detailed rules for awarding ranking points in individual criteria:

1) Result of completion of the master's degree

Result	Number of points Ranked
very good with distinction (5w)	20
very good (5)	15
a good plus (4+)	10
Good (4)	5
Below Good (Under 4)	0

2) Qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline

Specification	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
3) certificate of foreign language proficiency above B2	2

3) Candidate's scientific achievements

Specification	Number of Ranking Points
1) documented scientific publications published in 2017-2022, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267(3) of the Act	0 ÷ 15 pts for one monograph
b) a chapter in a multi-author monograph from the list referred to in Article 267(3) of the Act	0 ÷ 5 pts per chapter – no more than 10 points in total
c) scientific publication in journals from the list referred to in Article 267(3) of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 15 points.
e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 10 points.
2) Documented awards or scholarships	**0 ÷ 15 pts**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one prize or scholarship
b) obtaining a Rector's Award or Scholarship	0 ÷ 3 points
c) Distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 pts**
1. distinction in the competition for the best student work within the activities of the KNS	0 ÷ 3 points;
2. distinction for speaking at the KNS seminar	0 ÷ 2 pts.
4) documented participation in research projects - based on statements made by research project managers	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF formats*
2. *In the event that the sum of points from the sub-criteria exceeds the maximum value for this criterion, the candidate is awarded the maximum number of points for this criterion*

4) Doctoral dissertation concept

Specification	Number of Ranking Points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the dissertation topic and the justification for its selection, the definition of the research problem, aim, research questions, hypotheses, methodology and the presentation of the current state of research in the scope of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Number of Ranking Points
1) evaluation of the presentation of the doctoral dissertation concept in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) the proposed methodology, d) innovativeness and originality of the issues undertaken, e) presentation of the state of research in the field of design and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct scientific discussions, including consistency and transparency of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

(degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

(university/organisational unit)

STATEMENT

I declare that in the event of your admission:

(name and surname of the candidate)

to the Doctoral School of the Military University of Technology for the academic year 2022/2023, I hereby give preliminary consent to scientific supervision and acting as a supervisor within the research topics:

(research topics)

…….
(date)

……..
(signature of a potential supervisor)

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

(name and surname of the candidate)

(scientific discipline)

Doctoral dissertation concept[1]

……..
legible signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, defining: the research problem, aim, research questions, hypotheses, methodology and presenting the current state of research in the scope of the adopted subject matter - max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. MASTER DATA

1st Completed second-cycle studies (master's)

1)	name of the University	
2)	Field of study	
3)	Completion Score	
4)	Year of completion	
5)	title of the diploma thesis	
6)	name and surname of the thesis supervisor	

2nd Do you have a doctoral degree? If <u>so</u>, please attach a copy of your doctoral diploma or provisional certificate – *<u>attachment no. 1</u>*

3rd Have you been/been a participant in doctoral studies (third-cycle studies)? If <u>yes</u> , please specify the university/institute, scientific discipline, year of start - year of completion

4th Have you had or have you initiated a doctoral dissertation? If so, please specify the university/institute and scientific discipline and the topic of the dissertation.

5. Current employment

(name of the workplace, town, position held, status - professional soldier, police officer, prison service, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1st Trips abroad and individual studies:

1) mobility within the framework of programs, e.g. Erasmus – *<u>attachment no. 2</u>*

(name of the programme, date of departure, semester of study, host university, country)

2) Foreign internships – ***Appendix No. 3***

(name of traineeship, date, semester of study, host institution, country)

3) Individual studies - *attachment no. 4*

(semester(s) of study, level of study)

2nd Certificates and certificates proving the acquisition of qualifications needed for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3rd Document certifying knowledge of English at the level of language proficiency at least B2 - *attachment no. 6*[2]

(name of the certificate/attestation, supplement to the first-cycle diploma)

4th Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Annex No. 7*[3]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1st Publication activity in the years 2017 - 2022[4]:

1) monograph from the list referred to in Article 267(3) of the Act - ***Annex No. 8***

(author(s), title, publisher, year of publication, number of points)

2) a chapter in a multi-author monograph, from the list referred to in Article 267(3) of the Act - ***Appendix No. 9***

[2] in the case of:
- records certifying language proficiency at the B2 level in the supplement to the first-cycle diploma should be accompanied by this supplement
- certificate above B2, only this certificate should be attached,

[3] documents referred to in § 6 section 6 points 1-3

[4] in the case of:
- monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, the title page and abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

(author(s), title, monograph title, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267(3) of the Act - ***Annex No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267(3) of the Act - ***Annex No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication in peer-reviewed post-conference materials, in the list referred to in Article 267(3) of the Act - ***Annex No. 12***

(conference name, date, place, presentation topic, author(s)

2. Awards, scholarships

1) awards or scholarships of the minister competent for higher education and science or the Minister of National Defence – ***attachment no. 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***attachment no. 14***

(name of the award or scholarship, date of award)

3) Distinction for the best diploma thesis – ***attachment no. 15***

(engineering/bachelor's/master's thesis, date of award)

4) Other awards for research activities – ***Appendix No. 16***

(award title, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

1) distinction in the competition for the best student work within the activities of the KNS – ***attachment no. 17***

(the topic of the work, the date of awarding the distinction)

2) distinction for speaking at the KNS seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title/degree name and surname Manager Project	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the annex to the point/sub-point of the Questionnaire should contain a confirmation of all the information indicated in that point/sub-point,
- attachments should contain confirmations of awards, scholarships, distinctions obtained in the form of scans of diplomas, certificates, decisions,
- The candidate's participation in research projects is confirmed by the principal investigator's certificate, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, date	*Candidate's signature*

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

List
documents confirming knowledge of English
at least B2

In the recruitment procedure for the WAT Doctoral School, the following documents are accepted by the candidate confirming his/her knowledge of English at the level of at least B2 on the global language proficiency scale according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)":

1. Certificates issued by institutions affiliated to the Association of Language Testers in Europe (ALTE) – ALTE Level 3 (B2), ALTE Level 4 (C1), ALTE Level 5 (C2), in particular:
   1) First Certificate in English (FCE) or B2 First (FCE),
   2) Certificate in Advanced English (CAE) or C1 Advanced (CAE),
   3) Certificate of Proficiency in English (CPE) or C2 Proficiency (CPE),
   4) Business English Certificate (BEC) Vantage – at least Pass,
   5) Business English Certificate (BEC) Higher,
   6) Certificate in English for International Business and Trade (CEIBT);
2. Certificates from the following institutions:
   1) Educational Testing Service (ETS) – in particular certificates:
      a) Test of English as a Foreign Language (TOEFL) – at least 87 points in the Internet-Based Test (iBT) version,
      b) Test of English as a Foreign Language (TOEFL) – at least 180 points in the Computer-Based Test (CBT) version, supplemented by at least 50 points in the Test of Spoken English (TSE),
      c) Test of English as a Foreign Language (TOEFL) – at least 510 points in the Paper-Based Test (PBT), supplemented by at least 3.5 points in the Test of Written English (TWE) and at least 50 points in the Test of Spoken English (TSE),
      d) Test of English for International Communication (TOEIC) – at least 700 points;
   2) European Consortium for the Certificate of Attainment in Modern Languages (ECL);
   3) City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute – in particular certificates:
      a) English for Speakers of Other Languages (ESOL) – First Class Pass at Intermediate Level, Higher Intermediate Level, Advanced Level,
      b) International English for Speakers of Other Languages (IESOL) – "Communicator" level, "Expert" level, "Mastery" level,
      c) City & Guilds Level 1 Certificate in ESOL International (reading, writing and listening) Communicator (B2) 500/1765/2,

d) City & Guilds Level 2 Certificate in ESOL International (reading, writing and listening) Expert (C1) 500/1766/4,
e) City & Guilds Level 3 Certificate in ESOL International (reading, writing and listening) Mastery (C2) 500/1767/6,
f) Spoken English Test (SET) for Business – Stage B level "Communicator", Stage C level "Expert", Stage C level "Mastery",
g) English for Business Communications (EBC) – Level 2, Level 3,
h) English for Office Skills (EOS) – Level 2;

4) Edexcel, Pearson Language Tests, Pearson Language Assessments – in particular certificates:
a) London Tests of English, Level 3 (Edexcel Level 1 Certificate in ESOL International),
b) London Tests of English, Level 4 (Edexcel Level 2 Certificate in ESOL International),
c) London Tests of English, Level 5 (Edexcel Level 3 Certificate in ESOL International);

5) Education Development International (EDI), London Chamber of Commerce and Industry Examinations Board – in particular certificates:
a) London Chamber of Commerce and Industry Examinations (LCCI) – English for Business Level 2, English for Business Level 3, English for Business Level 4,
b) London Chamber of Commerce and Industry Examinations (LCCI) – Foundation Certificate for Teachers of Business English (FTBE),
c) London Chamber of Commerce and Industry Examinations (LCCI) – English for Tourism Level 2;

6) University of Cambridge ESOL Examinations, British Council, IDP IELTS Australia – in particular certificates:
a) International English Language Testing System IELTS – above 6 points,

7) telc GmbH, WBT Weiterbildungs-Testsysteme GmbH – in particular certificates:
a) B2 Certificate in English – advantage,
b) B2 Certificate in English for Business Purposes – advantage,
c) Certificate in English for Technical Purposes (B2),
d) telc English B2,
e) telc English B2 Business,
f) telc English B2 Technical,

3. Academic certificates issued by universities associated in the Association of Academic Centres for Teaching Foreign Languages SERMO – levels B2 and C1, in particular:
1) ACERT B2,
2) ACERT B2 Business English,
3) ACERT C1.
4. Certificate confirming knowledge of a foreign language issued by the National School of Public Administration as a result of a linguistic examination procedure.
5. Certificates confirming the achievement of at least the level of SPJ 3333 knowledge of English according to the NATO Standardization Agreement STANAG 6001.

6. Diplomas of completion of studies in the field of English Philology.
7. Information in the supplement to the diploma of graduation about passing the English language exam at the level of at least B2.
8. Diplomas containing a graphic sign indicating level 6 or 7. of the Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language pursued during the studies was English and the learning outcomes were achieved for English.
9. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
10. A document issued abroad considered equivalent to a secondary school leaving certificate if the language of instruction was English.
11. International Baccalaureate Diploma or European Baccalaureate.
12. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
13. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the possession of sworn translator qualifications in another Member State of the European Union, a member state of the European Free Trade Agreement (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
14. Other certificates, certificates, diplomas not mentioned above – if during the recruitment procedure the qualification team obtains the approval of the Head of the Head of the Technical University of Technology's Foreign Language Studies.

Appendix No. 6
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018. Law on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit and be admitted to the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and , subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Appendix No. 7
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **1 October 2022.**:

1. The Doctoral School of the Military University of Technology will be the only doctoral school where I will start my education;
2. I will not be employed as an academic or researcher;
3. I will/will not* be employed as an academic teacher or researcher under the conditions set out in Article 209(10)(1) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended);
4. I have/do not have* a doctoral degree;
5. I have/do not have* the certificate(s):
   1) about disability*,
   2) on the degree of disability* referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2021, as amended);

……..
legible signature of the candidate

Attachments:

……
……
**- delete unnecessary*

Remark:

In the cases referred to in:

- *point 3 - information on the candidate's employment for the purpose of carrying out a research project referred to in Article 119(2)(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended) should be attached),*
- *point 4 – a copy of the diploma conferring the academic degree of a doctor should be attached,*
- *point 5 – a copy of the decision should be attached.*

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 28/WAT/2023 of 23 February 2023

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended), in connection with § 21(1)(27) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021) The following is resolved:

§ 1

The "Rules of Recruitment to the Military University of Technology Doctoral School for the academic year 2023/2024" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

/-/ Brig. Gen. Prof. Przemysław Wachulak

Attachment
to Resolution No. 28/WAT/2023 of the WAT Senate
of 23 February 2023

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2023/2024

Section I
General

§ 1

1. The Doctoral School of the Jarosław Dąbrowski of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2023/2024, in the following scientific disciplines:
   1) automation, electronics, electrical engineering and space technologies,
   2) technical informatics and telecommunications,
   3) civil engineering, geodesy and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) safety sciences,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School is carried out by means of a competition in accordance with these Rules of Admission to the Doctoral School of the Military University of Technology for the academic year 2023/2024, hereinafter referred to as the "Recruitment Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines, within the framework of which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as those applicable to Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for the referral of professional soldiers to the Doctoral School are regulated by the provisions of the Act of 11 March 2022 on the Defence of the Homeland (i.e. Journal of Laws of 2022, item 655, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places for the Doctoral School is set by the Rector by 31 May 2023, at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2023, the Scientific Discipline Councils will establish lists of potential supervisors along with the thematic scope of the research and immediately forward them to the Director for publication on the Doctoral School's website.
10. At the request of the Chairman of the Scientific Discipline Council , the Director may make changes to the list referred to in paragraph 9 by 31 July 2023

Section II
Recruitment committee and qualification teams

§ 2

1. To conduct the recruitment procedure for the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Doctoral School's Admissions Committee, hereinafter referred to as the "Admissions Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "qualification team".
2. The Admission Committee and qualification teams are appointed by the Rector for the period from 20 March 2023 to 15 March 2024.
3. You are entitled to remuneration for your work in the recruitment committee and in the qualification team. In the decision referred to in paragraph 1, the Rector shall specify the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The recruitment committee consists of:
   1) chairman – director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the headteacher,
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. By 6 March 2023, the chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director the data of the representatives referred to in paragraph 1 point 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline.
3. At the request of the Chairperson of the Recruitment Committee, the Rector may appoint new or dismiss appointed members of the Recruitment Committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
7. Meetings of the committee may be held remotely. Decisions on the form of the meeting are made by the chairman of the recruitment committee.
8. The meetings of the recruitment committee are recorded. The minutes shall be signed by the chairperson of the recruitment committee and the members of the committee participating in the meeting, subject to paragraph 9.
9. In the case of a meeting of the committee conducted remotely, the minutes are signed only by the chairperson of the recruitment committee.
10. In the absence of the chairperson, the meeting of the committee shall be convened and chaired by a member of the committee authorised by the chairperson.
11. Tasks of the Recruitment Committee:
    1) supervision over the course of the recruitment procedure,

2) preparing and submitting to the qualification teams a template of the protocol and individual candidate evaluation sheets for the qualification teams,
3) preparation of candidate documents for qualification teams,
4) setting the dates of interviews within individual scientific disciplines,
5) setting individual interview dates and notifying candidates,
6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified to be included in the list of doctoral students,
7) publishing on the website of the Doctoral School a list of persons who have been pre-qualified and, after verifying the documents referred to in § 14 section 1, a list of persons admitted to the Doctoral School within individual scientific disciplines,
8) preparation of decisions on refusal of admission to the Doctoral School.

§ 4

1. The qualification team of a scientific discipline includes:
   1) chairman
   2) at least two members,
   3) secretary.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director by 6 March 2023 the data of candidates for:
   1) the chairperson and members of the team - from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline,
   2) secretary - from among the employees of the department related to the scientific discipline competent for the Council.
3. Tasks of qualification teams:
   1) analysis of candidates' documents submitted by the recruitment committee,
   2) analysis and assessment of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
   3) analysis of qualifications, competences and scientific achievements of candidates and awarding ranking points in accordance with point 2 points 1-3 of Annex No. 1 to the recruitment rules,
   4) analysis of the concept of the candidates' doctoral dissertation and awarding of ranking points in accordance with point 2 point 4 of Annex No. 1 to the recruitment rules,
   5) conducting an interview and awarding ranking points in accordance with point 2 point 5 of Appendix No. 1 to the Recruitment Rules.
   6) determining the total, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the Recruitment Rules,
   7) submission of the protocol to the Recruitment Committee together with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:

a) pre-qualification of candidates for inclusion on the list of doctoral students,
b) a proposal to change the limit of places for a scientific discipline,
c) establishing a reserve list,

8) preparing information for the Recruitment Committee on the course of the selection procedure in the event of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and members of the qualification team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairperson of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairperson of the qualification team of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School.
3. A member of the qualification team is subject to exclusion from the assessment of the candidate , in particular if:
   1) has provided the candidate with the statement referred to in § 6 section 1 point 3,
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.
4. The Chairperson may exclude himself from the assessment of the candidate in the cases referred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate shall be recorded in the protocol of the qualification team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 if they are:
   1) have a master's degree, a master's degree in engineering or an equivalent degree,

2) have a documented knowledge of English at the level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 4 – the list of documents confirming knowledge of English at the level of at least B2 is contained in Appendix No. 5 to the Recruitment Rules
3) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.

2. In exceptional cases, justified by the highest quality of scientific achievements, graduates of first-cycle studies or students who have completed the third year of long-cycle master's studies meeting the requirements referred to in paragraph 1 points 2 and 3 may apply for admission to the Doctoral School.
3. In the absence of a master's degree due to waiting for its issuance, the candidate is obliged to present a certificate from the university on obtaining a master's degree.
4. A certificate is not required for native English speakers.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at the B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of Polish, i.e.:
   1) complete a one-year preparatory course for taking up education in Polish in units designated by the minister competent for higher education, or
   2) have a certificate of knowledge of the Polish language issued by the State Commission for the Certification of Knowledge of Polish as a Foreign Language, or
   3) have completed their studies in Poland in a field of study conducted in Polish, or
   4) During the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.
7. If the Master's degree was issued in a language other than Polish or English, the candidate must attach a sworn translation.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Internet Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee **– 1-15 August 2023,**
   2) Qualification procedure – **August 16 - September 7, 2023,** including:
      a) interviews – **August 28 – September 1, 2023,**
   3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 8 September 2023**,
   4) issuance of an administrative decision on refusal to admit to the Doctoral School to candidates not qualified to be entered on the list of doctoral students **– 12-15 September 2023**,

5) submission by candidates pre-qualified to be entered on the list of doctoral students of the documents referred to in § 14 section 1 – **8-18 September 2023,**
6) announcement of the list of those admitted to the Doctoral School **- September 20, 2023**

2. The Admission Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2023.
3. The lists of candidates and admitted candidates referred to in paragraph 1 points 3 and 6 are published on the website of the Doctoral School.

Chapter III
Registration and documents to be filed

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) familiarize yourself with these recruitment rules,
   2) prepare electronic versions of the documents referred to in paragraph 4,
   3) selecting a potential supervisor and the proposed scope of research topics from the list referred to in § 1 section 9, conducting an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtaining a statement - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. Registration of candidates for the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the website of the Doctoral School and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to paragraphs 5 and 6:
   1) an application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the obtaining of a master's degree, a master's degree in engineering or an equivalent degree,
   3) a diploma supplement or other document confirming the course of studies,
   4) a statement of a potential supervisor – according to the template contained in Appendix No. 2 to the Recruitment Rules,
   5) the concept of the doctoral dissertation – according to the template contained in Appendix No. 3 to the Recruitment Rules,
   6) a signed information questionnaire with attachments - according to the template contained in Appendix 4 to the Recruitment Rules,
   7) a document certifying knowledge of English at the level of language proficiency at least B2 – the list of documents is contained in Appendix No. 5 to the Recruitment Rules;
   8) curriculum vitae (CV);
   9) a signed information clause regarding the processing of personal data – according to the template contained in Appendix No. 6 to the Recruitment Rules.

5. Candidates, beneficiaries of the "Diamond Grant" programme, in addition to the documentsreferred to in paragraph 4, submit a document confirming that they have obtained the "Diamond Grant".
6. Candidates referred to in § 6 section 2 shall submit:
   1) documents referred to in paragraph 4 points 1 and 4-7,
   2) a diploma confirming the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies,
   3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act apply to the recognition of a diploma as entitling to undertake education at the Doctoral School.
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the Recruitment Committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.

Chapter IV
Enrolment fee

§ 9

1. The admission fee to the Doctoral School is PLN 200.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **August 15, 2023.**
3. In a particularly justified case, the candidate may, by 5 August 2023, submit an application to the Rector for exemption from the recruitment fee at the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
4. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.
5. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 3 or the expiry of the deadline referred to in paragraph 4, the candidate shall not be subject to the qualification procedure.
6. The candidate is entitled – at his/her request – to a refund of the recruitment fee in the event of:
   1) resignation from participation in the selection procedure before its commencement, i.e. before 15 August 2023;
   2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by a qualification team appropriate for the scientific discipline selected by the candidate and includes:
   1) analysis and evaluation of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
   2) awarding ranking points in the following criteria:
      a) the result of completing master's studies,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) the concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards candidates with ranking points in individual criteria on the terms set out in Appendix No. 1 to the Recruitment Rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the event of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside Polish, the qualification team competent for the scientific discipline selected by the candidate may ask the candidate to submit additional documents.
5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c.
6. In the case of a beneficiary of the Diamond Grant programme, the qualification team shall award the candidate 60 points for the criteria referred to in paragraph 1(2)(a-c), irrespective of the candidate's results in those criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b-e) shall be the arithmetic average of the points awarded by each member of the qualification team, rounded up to one decimal place, and shall not exceed the maximum value specified for the criterion in question.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the completion of the selection procedure, the qualification team shall immediately submit to the recruitment committee the completed and signed documents referred to in § 3 section 11 point 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and his/her scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date and place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 is provided to candidates

electronically to the e-mail address indicated in the IRK system and is published on the website of the Doctoral School by 21 August 2023.

3. The interview can be conducted in a stationary or remote form using commonly available online tools. The preferred messenger is MS Teams.
4. Before the interview begins, the chair or secretary of the selection team is obliged to verify the identity of the candidate.
5. The interview consists of two parts:
    1) the first part – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) The second part – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the introductory topic of the doctoral dissertation,
    2) justification for the choice of topic, results of the analysis of the state of knowledge in the field of selected research issues, literature review,
    3) initial definition of the research problem (objective, research questions, hypotheses),
    4) the proposed methodology,
    5) expected results.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the Admission Committee may order the Qualification Team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the case of:
    1) meeting the formal requirements referred to in § 6 section 1,
    2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
    3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
    4) obtaining a total of at least 55 ranking points, including at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 makes it impossible to enter a candidate on the ranking list of candidates even if the limit of places specified for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee prepares a protocol on the recruitment process, to which a document called the ranking list of candidates is attached, containing

information about the candidates pre-qualified for entry on the list of doctoral students.

3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admissions committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2023/2024.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) name and surnames of the candidate,
   2) final result – the sum of the ranking points,
   3) indicate whether the candidate has been pre-qualified to be entered on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the recruitment committee.

Chapter VII
Admission and Refusal of Admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after being delivered to the Dean's Office of the Doctoral School no later than by 18 September 2023.
   1) statements in accordance with the template specified in Annex 7 to the Recruitment Rules,
   2) a diploma of completion of second-cycle studies, long-cycle master's studies or equivalent obtained on the basis of separate regulations or a certificate of obtaining a master's degree.
2. In special cases, the chairperson of the selection committee may set a deadline for other candidates to submit the documents referred to in paragraph 1.
3. Failure to meet the requirements set out in paragraph 1 results in the candidate being removed from the list of those pre-qualified for inclusion on the list of doctoral students and the admissions committee applying to the Rector for a decision on refusal to admit him to the Doctoral School.
4. Candidates who meet the conditions referred to in § 12 section 2 and have not been admitted due to the exhaustion of the limit of places specified for the scientific discipline constitute a reserve group. In the event of vacancies on the

list of pre-qualified candidates for the Doctoral School for the academic year 2023/2024 in the scientific discipline chosen by the candidate, these persons may, by the decision of the Rector, be admitted to the Doctoral School in the order resulting from the number of points obtained.

5. The admissions committee immediately informs the candidate of admission in this manner. The provisions of paragraphs 1 and 2 shall apply accordingly, whereby thecandidate is obliged to submit the declaration referred to in paragraph 1 within seven days from the date of providing information about this obligation, failing which the qualification will expire by law.

§ 15

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School under a special recruitment procedure takes place as a separate competition procedure, outside the limits of places specified in § 1 section 8, the rules of which take into account these recruitment rules and the rules specified for the programme, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. The common rules of recruitment are approved by the chairperson of the recruitment committee after agreement with the representatives of the competent institution or the manager of the programme, project, grant or contract
3. Special recruitment procedures for the Doctoral School are conducted by the Admission Committee and the qualification teams referred to in § 2 section 1, subject to paragraphs 4 and 5.
4. The meetings of the selection teams and the selection committee as part of the special recruitment procedure may be attended by the representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activities of the admissions committee and qualification teams during a special recruitment procedure, the Rector may extend their activity until the end of this procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2023/2024 only on condition that they ensure, throughout the entire period of education, full funding from doctoral scholarship programmes, projects, grants or agreements in the

amount of not less than the amount of the scholarship specified in Article 209(4) of the Act and a possible increase in the scholarship and co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.

8. The period of education referred to in paragraph 6 also includes the period of suspension of education and extension of the deadline for submitting a doctoral dissertation.
9. The condition for admission to the Doctoral School and financing of the candidates referred to in paragraph 7 is an agreement specifying the conditions for the implementation, financing and settlement of financial resources for the financing of the scholarship or doctoral scholarships, the increase in the amount of the scholarship or scholarships and the costs of social security incurred by WAT and, if necessary, the co-financing of the costs of using the research infrastructure, as well as the financing of activities related to the procedurefor the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Education and Science on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for implementation recruitment should be recruited from among the employees of enterprises and other entities cooperating with the Military Military Academy.
3. By 31 March 2023, the Recruitment Committee determines:
   1) schedule of implementation recruitment,
   2) a list and templates of documents submitted by a potential supervisor and candidate at each stage of recruitment,
   3) the manner and place or form of submission of documents.
4. Implementation recruitment is carried out by the recruitment committee and qualification teams in two stages:
   1) preliminary stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee referred to in § 9 section 1 and 2, within the deadline specified in the schedule referred to in paragraph 3 point 1,
   2) submission of documents by the recruitment committee to the qualification team competent for the scientific discipline,
   3) Qualification proceedings conducted by the qualification team, in the scope of:
      a) analysis and evaluation of the topic of the doctoral dissertation submitted by the candidate and the scientific achievements of the potential supervisor,

b) meeting the candidate's formal requirements for:
   - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'CC programme',
   - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 point 1,
c) conducting an interview,
d) awarding ranking points for the criteria referred to in §10 section 1 point 2,
e) provide the admissions committee with the documents referred to in subsection 3(3) together with recommendations to the admissions committee regarding the candidate's qualifications for the DW programme.

6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in paragraph 5(3)(b), obtain a positive assessment referred to in paragraph 5(3)(a) and score a minimum of 20 points from the interview.
7. Prior to accepting the protocols of the qualification teams, the Selection Committee may order the qualification team to re-conduct the qualification procedure referred to in paragraph 5(a), (b) and (d).
8. The admissions committee prepares a protocol of the course of the initial stage, to which, in the case of positive acceptance of the candidates, it attaches a document called the ranking list, containing information about the candidates pre-qualified for entry on the list of doctoral students under the DW program.
9. On the basis of the protocol of the recruitment committee from the preliminary stage:
   1) is submitted, through the Integrated System of Services for Science Servicing Funding Streams (ZSUN/OSF), an application to the minister responsible for higher education and science, hereinafter referred to as the "Minister"
   , for the qualification of a candidate for participation in the DW programme, or
   2) in the event of failure to meet the requirements referred to in paragraph 6, the candidate receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2023/2024 as part of the programme.
10. The applications referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.
11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is placed on the website of the Doctoral School and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the initial stage and includes:
   1) the candidate provides documents for this stage, specified in paragraph 3 point 2,
   2) conducting the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 14,
   3) preparation of the final protocol from the implementation recruitment by the recruitment committee.
13. The admissions committee may, at any stage of the induction recruitment, call upon the candidate to submit additional documents confirming that they meet the requirements for participation in the DW program.

14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application to participate in the DW programme for the academic year 2023/2024.
15. If the Minister provides information on the non-qualification of the WAT application for participation in the DW programme, the Rector issues a decision refusing to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final protocol of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2023/2024 as part of the DW program, or
    2) receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2023/2024 under this programme.
17. Participation of a candidate in the induction recruitment does not exclude, at his or her request, participation in the recruitment to the Doctoral School for the academic year 2023/2024.

Chapter III
Other programs, projects, grants, agreements

§ 18

1. Special recruitment procedures may also be conducted under other programs, projects, grants or contracts.
2. The detailed rules of the procedures referred to in paragraph 1 shall be determined by the recruitment committee, at least 14 days before the start of the recruitment process, taking into account the candidates' fulfilment of the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or contract.
3. Selection procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions shall apply:
    1) Act
    2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the recognition of diplomas of completion of studies abroad and confirmation of completion of studies at a certain level (Journal of Laws of 28 September 2018).item 1881),
    3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2022, item 2000, as amended).

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

Detailed rules awarding ranking points

1. **Qualifying teams award ranking points to candidates according to the following criteria:**

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in § 10 section 5 and 6 of the Recruitment Rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Doctoral dissertation concept	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. **Detailed rules for awarding ranking points in individual criteria:**
   1) **Result of completion of the master's degree**

Result	Number of points Ranked
very good with distinction (5w)	20
very good (5)	15
a good plus (4+)	10
Good (4)	5
Below Good (Under 4)	0

   2) **Qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline**

Specification	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, certificate of any foreign language above B2, etc.)	0 ÷ 5

3) Candidate's scientific achievements

Specification	Number of Ranking Points
1) documented scientific publications published in the years 2016-2023, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267(3) of the Act	0 ÷ 15 pts for one monograph
b) a chapter in a multi-author monograph from the list referred to in Article 267(3) of the Act	0 ÷ 5 pts per chapter – no more than 10 points in total
c) scientific publication in journals from the list referred to in Article 267(3) of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 15 points.
e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 10 points.
2) Documented awards or scholarships	**0 ÷ 15 pts**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one prize or scholarship
b) obtaining a Rector's Award or Scholarship	0 ÷ 3 points
c) Distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 pts**
1. distinction in the competition for the best student work within the activities of the KNS	0 ÷ 3 points;
2. distinction for speaking at the KNS seminar	0 ÷ 2 pts.
4) documented participation in research projects - based on statements made by research project managers	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF formats*
2. *In the event that the sum of points from the sub-criteria exceeds the maximum value for this criterion, the candidate is awarded the maximum number of points for this criterion*

4) Doctoral dissertation concept

Specification	Number of Ranking Points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the dissertation topic and the justification for its selection, the definition of the research problem, aim, research questions, hypotheses, methodology and the presentation of the current state of research in the scope of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Number of Ranking Points
1) evaluation of the presentation of the doctoral dissertation concept in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) the proposed methodology, d) innovativeness and originality of the issues undertaken, e) presentation of the state of research in the field of design and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct scientific discussions, including consistency and transparency of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

(degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

(university/organisational unit)

STATEMENT

I declare that in the event of your admission:

(name and surname of the candidate)

to the Doctoral School of the Military University of Technology for the academic year 2023/2024, I give preliminary consent to scientific supervision and acting as a supervisor within the research topics:

(research topics)

……. ……..
(date) *(signature of a potential supervisor)*

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

(name and surname of the candidate)

(scientific discipline)

Doctoral dissertation concept[1]

……..
legible signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, defining: the research problem, aim, research questions, hypotheses, methodology and presenting the current state of research in the scope of the adopted subject matter - **max. 5000 characters without spaces,** Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. MASTER DATA

1st Completed second-cycle studies (master's)

1)	name of the university	
2)	Field of study	
3)	Completion Score	
4)	Year of completion	
5)	title of the diploma thesis	
6)	name and surname of the thesis supervisor	

2nd Do you have a doctoral degree? If <u>so</u>, please attach a copy of your doctoral diploma or provisional certificate – *<u>attachment no. 1</u>*

3rd Have you had or have initiated a doctoral procedure or a procedure for awarding a doctoral degree? If so, please specify the university/institute and scientific discipline and the topic of the dissertation.

4th Have you been or are you a participant in doctoral studies (third-cycle studies)? If <u>yes</u> , please specify the university/institute, scientific discipline, year of start - year of completion

5th Have you been or are you a PhD student at a doctoral school? If <u>so</u> , please provide the name of the doctoral school, scientific discipline, date of commencement and end of education

6th Current employment

(name of the workplace, town, position held, status - professional soldier, police officer, prison service, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1st Trips abroad and individual studies:

1) **mobility within the framework of programs, e.g. Erasmus – *attachment no. 2***

(name of the programme, date of departure, semester of study, host university, country)

2) **Foreign internships – *Appendix No. 3***

(name of traineeship, date, semester of study, host institution, country)

3) **Individual studies - *attachment no. 4***

(semester(s) of study, level of study)

2nd Certificates and certificates proving the acquisition of qualifications needed for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3rd Document certifying knowledge of a foreign language at the level of language proficiency above B2 - *attachment no. 6*[1]

(name of certificate/attestation)

4th Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Annex No. 7*[2]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1st Publication activity in the years 2016 - 2023[3]:

1) monograph from the list referred to in Article 267(3) of the Act - ***Annex No. 8***

(author(s), title, publisher, year of publication, number of points)

[1] documents confirming knowledge of any foreign language at a level above B2, e.g. C1, C2, above SPJ 3333

[2] documents referred to in § 6 section 6 points 1-3

[3] in the case of:

- monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, the title page and abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

2) a chapter in a multi-author monograph, from the list referred to in Article 267(3) of the Act - ***Appendix No. 9***

(author(s), title, monograph title, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267(3) of the Act - ***Annex No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267(3) of the Act - ***Annex No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication
in peer-reviewed post-conference materials, in the list referred to in Article 267(3) of the Act - ***Annex No. 12***

(conference name, date, place, presentation topic, author(s)

2nd Awards, scholarships

1) awards or scholarships of the minister competent for higher education and science or the Minister of National Defence – ***attachment no. 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***attachment no. 14***

(name of the award or scholarship, date of award)

3) Distinction for the best diploma thesis – ***attachment no. 15***

(engineering/bachelor's/master's thesis, date of award)

4) Other awards for research activities – ***Appendix No. 16***

(award title, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

1) distinction in the competition for the best student work within the activities of the KNS – ***attachment no. 17***

(the topic of the work, the date of awarding the distinction)

2) distinction for speaking at the KNS seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title/degree name and surname Manager Project	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the annex to the point/sub-point of the Questionnaire should contain a confirmation of all the information indicated in that point/sub-point,
- attachments should contain confirmations of awards, scholarships, distinctions obtained in the form of scans of diplomas, certificates, decisions,
- The candidate's participation in research projects is confirmed by the principal investigator's certificate, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, date	*Candidate's signature*

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

List
documents confirming knowledge of English
at least B2

In the recruitment procedure for the WAT Doctoral School, the following documents are accepted by the candidate confirming his/her knowledge of English at the level of at least B2 on the global language proficiency scale according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)":

1. Certificates issued by institutions affiliated to the Association of Language Testers in Europe (ALTE) – ALTE Level 3 (B2), ALTE Level 4 (C1), ALTE Level 5 (C2), in particular:
   1) First Certificate in English (FCE) or B2 First (FCE),
   2) Certificate in Advanced English (CAE) or C1 Advanced (CAE),
   3) Certificate of Proficiency in English (CPE) or C2 Proficiency (CPE),
   4) Business English Certificate (BEC) Vantage – at least Pass,
   5) Business English Certificate (BEC) Higher,
   6) Certificate in English for International Business and Trade (CEIBT);
2. Certificates from the following institutions:
   1) Educational Testing Service (ETS) – in particular certificates:
      a) Test of English as a Foreign Language (TOEFL) – at least 87 points in the Internet-Based Test (iBT) version,
      b) Test of English as a Foreign Language (TOEFL) – at least 180 points in the Computer-Based Test (CBT) version, supplemented by at least 50 points in the Test of Spoken English (TSE),
      c) Test of English as a Foreign Language (TOEFL) – at least 510 points in the Paper-Based Test (PBT), supplemented by at least 3.5 points in the Test of Written English (TWE) and at least 50 points in the Test of Spoken English (TSE),
      d) Test of English for International Communication (TOEIC) – at least 700 points;
   2) European Consortium for the Certificate of Attainment in Modern Languages (ECL);
   3) City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute – in particular certificates:
      a) English for Speakers of Other Languages (ESOL) – First Class Pass at Intermediate Level, Higher Intermediate Level, Advanced Level,
      b) International English for Speakers of Other Languages (IESOL) – "Communicator" level, "Expert" level, "Mastery" level,
      c) City & Guilds Level 1 Certificate in ESOL International (reading, writing and listening) Communicator (B2) 500/1765/2,

d) City & Guilds Level 2 Certificate in ESOL International (reading, writing and listening) Expert (C1) 500/1766/4,
e) City & Guilds Level 3 Certificate in ESOL International (reading, writing and listening) Mastery (C2) 500/1767/6,
f) Spoken English Test (SET) for Business – Stage B level "Communicator", Stage C level "Expert", Stage C level "Mastery",
g) English for Business Communications (EBC) – Level 2, Level 3,
h) English for Office Skills (EOS) – Level 2;

4) Edexcel, Pearson Language Tests, Pearson Language Assessments – in particular certificates:
a) London Tests of English, Level 3 (Edexcel Level 1 Certificate in ESOL International),
b) London Tests of English, Level 4 (Edexcel Level 2 Certificate in ESOL International),
c) London Tests of English, Level 5 (Edexcel Level 3 Certificate in ESOL International);

5) Education Development International (EDI), London Chamber of Commerce and Industry Examinations Board – in particular certificates:
a) London Chamber of Commerce and Industry Examinations (LCCI) – English for Business Level 2, English for Business Level 3, English for Business Level 4,
b) London Chamber of Commerce and Industry Examinations (LCCI) – Foundation Certificate for Teachers of Business English (FTBE),
c) London Chamber of Commerce and Industry Examinations (LCCI) – English for Tourism Level 2;

6) University of Cambridge ESOL Examinations, British Council, IDP IELTS Australia – in particular certificates:
a) International English Language Testing System IELTS – above 6 points,

7) telc GmbH, WBT Weiterbildungs-Testsysteme GmbH – in particular certificates:
a) B2 Certificate in English – advantage,
b) B2 Certificate in English for Business Purposes – advantage,
c) Certificate in English for Technical Purposes (B2),
d) telc English B2,
e) telc English B2 Business,
f) telc English B2 Technical,

3. Academic certificates issued by universities associated in the Association of Academic Centres for Teaching Foreign Languages SERMO – levels B2 and C1, in particular:
1) ACERT B2,
2) ACERT B2 Business English,
3) ACERT C1.
4. Certificate confirming knowledge of a foreign language issued by the National School of Public Administration as a result of a linguistic examination procedure.
5. Certificates confirming the achievement of at least the level of SPJ 3333 knowledge of English according to the NATO Standardization Agreement STANAG 6001.

6. Diplomas of completion of studies in the field of English Philology.
7. Information in the supplement to the diploma of graduation about passing the English language exam at the level of at least B2.
8. Diplomas containing a graphic sign indicating level 6 or 7. of the Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language pursued during the studies was English and the learning outcomes were achieved for English.
9. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
10. A document issued abroad considered equivalent to a secondary school leaving certificate if the language of instruction was English.
11. International Baccalaureate Diploma or European Baccalaureate.
12. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
13. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the possession of sworn translator qualifications in another Member State of the European Union, a member state of the European Free Trade Agreement (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
14. Other certificates, certificates, diplomas not mentioned above – if they are approved by the Head of the Head of the Military University of Technology's Foreign Language Department.

Appendix No. 6
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018. Law on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit and be admitted to the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and , subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Appendix No. 7
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **1 October 2023.**:

1. The Doctoral School of the Military University of Technology will be the only doctoral school where I will carry out my education;
2. I will/will not* be employed as an academic teacher/researcher*[1];
3. I have/do not have* a doctoral degree[2];
4. I have/do not have* the certificate(s):[3]
   1) about disability*,
   2) on the degree of disability*, referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2021, item 573, as amended).

……..
legible signature of the candidate

Attachments:

1. ……
2. ……

**- delete unnecessary*

[1] the candidate may be employed as an academic teacher or researcher only in the case of employment for the purpose of carrying out a research project referred to in Article 119(2)(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended) – in this case, information on the candidate's employment should be attached
[2] in the case of holding a doctoral degree, a copy of the diploma conferring the doctoral degree or a provisional certificate must be attached
[3] If you have a certificate, you should attach a copy of it

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology
Jarosław Dąbrowski

No. 11/WAT/2024 of 29 February 2024

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
Jarosław Dąbrowski for the academic year 2024/2025

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2023, item 742, as amended),
in connection with § 21 section 1 point 27 of the Statute of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), it is hereby resolved, as follows:

§ 1

The "Rules of recruitment to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2024/2025" *are hereby defined,* constituting an attachment to the resolution.

§ 2

The resolution shall enter into force on the date of its adoption.

W zastępstwie przewodniczącego Senatu

(-) prof. dr hab. inż. Jerzy MAŁACHOWSKI

Attachment
to Resolution No. 11/WAT/2024 of the Senate of the Military University of Technology
of 29 February 2024

Recruitment rules
for the Doctoral School of the Military University of Technology Jarosław Dąbrowski for the academic year 2024/2025

Section I
General

§ 1

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2024/2025, in the following scientific disciplines:
   1) automation, electronics, electrical engineering and space technologies,
   2) technical information technology and telecommunications,
   3) civil engineering, geodesy and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) security sciences,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School takes place through a competition in accordance
   with these Recruitment Rules for the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2024/2025, hereinafter referred to as the "recruitment rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines within which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School takes place on the same terms as for Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2023, item 742, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for sending professional soldiers to the Doctoral School in the service mode are regulated by the provisions of the Act of 11 March 2022 on the Defence of the Homeland (i.e. Journal of Laws of 2022, item 2305, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places in the Doctoral School is determined by the Rector by 31 May 2024, at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2024, the Councils of Scientific Disciplines will establish lists of potential supervisors along with the thematic scope of research.

10. The Councils for Scientific Disciplines may amend the lists referred to in paragraph 9 by 31 July 2024.
11. The resolutions referred to in paragraphs 9 and 10 shall be immediately forwarded by the Chairman of the Scientific Discipline Council to the Director.

Section II
Selection committee and selection teams

§ 2

1. To conduct the recruitment procedure to the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Admission Committee of the Doctoral School, hereinafter referred to as the "Admission Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "Qualification Team".
2. The admissions committee and qualification teams are appointed by the Rector for the period from 1 April 2024 to 31 March 2025.
3. Work in the recruitment committee and in the qualification team is remunerated. In the decision referred to in paragraph 1, the Rector lays down the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The admissions committee consists of:
   1) chairman – the director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the head,
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. By 15 March 2024, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 section 1 shall provide the Director with the data of the representatives referred to in paragraph 1 item 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity within the scope of this scientific discipline.
3. At the request of the chairperson of the admissions committee, the rector may appoint new or dismiss appointed members of the admissions committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the deliberations of the Admission Committee as an observer.
5. Administrative support for the recruitment committee is provided by the Dean's Office of the Doctoral School.
6. The chairman of the admissions committee convenes meetings of the admissions committee and chairs its meetings.
7. Committee meetings may be held remotely. Decisions on the form of the meeting are made by the chairman of the admissions committee.
8. Meetings of the admissions committee are recorded. The minutes are signed by the chairman of the admissions committee and the members of the committee participating in the meeting, subject to paragraph 9.
9. In the case of a committee meeting conducted remotely, the minutes are signed only by the chairman of the admission committee.

10. In the absence of the chairman, the committee meeting is convened and chaired by a committee member authorized by the chairman.
11. Tasks of the admissions committee:
    1) supervision over the recruitment procedure,
    2) preparing and providing qualification teams with a template of the protocol and individual candidate evaluation cards for qualification teams,
    3) preparation of candidate documents for qualification teams,
    4) setting the dates of interviews within individual scientific disciplines,
    5) setting individual dates for interviews and notifying candidates,
    6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified for entry on the list of doctoral students,
    7) publication on the Doctoral School's website of the list of pre-qualified persons and, after verification of the documents referred to in § 14 section 1, the list of persons admitted to the Doctoral School within individual scientific disciplines,
    8) preparation of a decision on refusal of admission to the Doctoral School.

§ 4

1. The qualification team for a scientific discipline includes:
    1) chairman
    2) at least two members,
    3) secretary.
2. By 15 March 2024, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 section 1 shall provide the Director with the data of candidates for:
    1) the chairperson and members of the team – from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline,
    2) secretary - from among the employees of the faculty related to the scientific discipline appropriate for the Council.
3. Tasks of the qualification teams:
    1) analysis of candidates' documents submitted by the recruitment committee,
    2) analysis and assessment of the relationship between the candidate's completed master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
    3) analysis of qualifications and competences as well as scientific achievements of candidates and awarding ranking points in accordance with point 2 subsections 1-3 of Appendix No. 1 to the recruitment rules,
    4) analysis of the concept of the doctoral dissertation of the candidates and awarding ranking points in accordance with point 2 subsection 4 of Annex 1 to the recruitment rules,
    5) conducting an interview and awarding ranking points in accordance with point 2 subsection 5 of Appendix No. 1 to the recruitment rules.

6) determining the general, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the recruitment rules,
7) Submission of the protocol to the Recruitment Committee along with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:
   a) pre-qualification of candidates for entry on the list of doctoral students,
   b) a proposal to change the limit of places for a scientific discipline,
   c) establishing a reserve list,
8) preparing information for the admissions committee on the course of the qualification procedure in the case of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and the members of the selection team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairman of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairman of the qualification team of any circumstances that may affect his or her impartiality and objectivity in the assessment of candidates for the Doctoral School.
3. A member of the selection team is excluded from the candidate's assessment in particular if:
   1) provided the candidate with the statement referred to in § 6 section 1 point 3,
   2) he was the supervisor of the candidate's master's thesis;
   3) is the candidate's superior or is in another employment relationship with the candidate;
   4) the candidate is or was his/her spouse or is a relative or in-law to the second degree, or remains or has been cohabiting with a member of the admissions committee;
   5) the candidate is or was a person related to a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to the impartiality and objectivity of the candidate's assessment.
4. The chairperson may exclude himself from the evaluation of a candidate in the cases referred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate is recorded in the report of the selection team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 who:
   1) hold a master's degree, a master's degree in engineering or an equivalent title,
   2) have a documented knowledge of English at the level of language proficiency at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 4 – the list of documents confirming knowledge of English at least at the B2 level is included in Annex 5 to the admission rules
   3) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor, from the list referred to in § 1 section 9 - the template of the statement is included in Appendix No. 2 to the recruitment rules.
2. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may be applied for admission by graduates of first-cycle studies or students who have completed the third year of long-cycle studies who meet the requirements referred to in section 1 points 2 and 3.
3. In the absence of a master's degree diploma due to waiting for its issuance, the candidate is obliged to present a certificate from the university confirming the award of a master's degree.
4. The certificate is not required for native English speakers.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of the Polish language, i.e.:
   1) have completed a one-year preparatory course to study in Polish in units designated by the minister responsible for higher education, or
   2) have a certificate of proficiency in Polish issued by the State Commission for the Certification of Proficiency in Polish as a Foreign Language or
   3) have completed studies in Poland in a field of study conducted in Polish, or
   4) during the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.
7. If the Master's degree diploma was issued in a language other than Polish or English, the candidate shall attach a certified translation.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Online Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee - **1-18 August 2024,**
   2) qualification procedure - **19 August - 13 September 2024,** including:
      a) interviews - **11 – 13 September 2024,**
   3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 17 September 2024**,

4) issuance of an administrative decision on refusal of admission to the Doctoral School to candidates not qualified for entry on the list of doctoral students **– September 19-23, 2024**,
5) submission by candidates pre-qualified for entry on the list of doctoral students of the documents referred to in § 14 section 1 – **17-23 September 2024,**
6) announcement of the list of those admitted to the Doctoral School **- September 24, 2024**

2. The Admission Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2024, subject to paragraph 3
3. In the case of a large number of candidates, changes to the deadlines for the activities referred to in paragraph 1(2)(a) and (3)-(6) may be introduced until 20 August 2024.
4. The lists of candidates and accepted candidates referred to in paragraph 1 points 3 and 6 are published on the Doctoral School website.

Chapter III
Registration and submission

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) read these recruitment rules,
   2) preparation of electronic versions of the documents referred to in paragraph 4,
   3) select a potential supervisor and the proposed scope of research from the list referred to in § 1 section 9, hold an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtain a statement - the template of the statement is included in Appendix 2 to the recruitment rules.
2. Registration of candidates to the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the Doctoral School's website and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to sections 5 and 6:
   1) application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the award of a master's degree, a master's degree in engineering or an equivalent title,
   3) a supplement to the Master's Diploma or another document confirming the course of study,
   4) declaration of the potential supervisor – according to the template included
      in Appendix No. 2 to the recruitment rules,
   5) concept of the doctoral dissertation – according to the template included in Appendix 3 to the recruitment rules,

6) signed information questionnaire with attachments - according to the template included in Appendix No. 4 to the recruitment rules,
7) a document certifying knowledge of English at the level of language proficiency at least B2 – the list of documents is included in Appendix 5 to the recruitment rules;
8) curriculum vitae (CV);
9) a signed information clause regarding the processing of personal data – according to the template included in Appendix No. 6 to the recruitment rules.

5. Candidates, beneficiaries of the "Diamond Grant" program, in addition to the documents
referred to in paragraph 4, submit a document confirming the receipt of the "Diamond Grant".
6. The candidates referred to in § 6 section 2 submit:
1) documents referred to in section 4 points 1 and 4-7,
2) a diploma confirming the award of an engineer's or bachelor's degree or a certificate of completion of the third year of long-cycle master's degree studies,
3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming the achievement of a second-degree qualification outside Polish shall additionally submit a translation of the diploma prepared by a sworn translator. To recognize a diploma as entitling to undertake education at the Doctoral School, the provisions of Articles 326 and 327 of the Act apply.
8. In the event of submission of incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the recruitment committee calls on the candidate to supplement them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the prescribed period results in the candidate's application not being considered, and thus the candidate is not allowed to participate in the qualification procedure.

Chapter IV
Application fee

§ 9

1. The amount of the recruitment fee to the Doctoral School is determined by the Rector by 31 May 2024.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **by 18 August 2024.**
3. In a particularly justified case, the candidate may, by 5 August 2024, submit an application to the Rector for exemption from the application fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submitting the application.
4. In the event of refusal to exempt from the fee, the candidate is obliged to pay the application fee within 7 days of providing this information.
5. If the payment is not made within the time limit referred to in paragraph 2 or the application referred to in paragraph 3 is not submitted or the deadline referred to in paragraph 4 expires, the candidate is not subject to the qualification procedure.

6. A candidate is entitled – at his/her request – to a refund of the application fee in the case of:
   1) resign from participation in the qualification procedure before its commencement, i.e. before 19 August 2024;
   2) refusal to initiate the admission procedure in relation to a candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by the qualification team competent for the scientific discipline chosen by the candidate and includes:
   1) analysis and assessment of the relationship between the candidate's completed Master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
   2) awarding ranking points in the following criteria:
      a) the result of completing a master's degree,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards ranking points to candidates in individual criteria on the terms set out in Appendix 1 to the recruitment rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the case of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside of Polish, the qualification team competent for the scientific discipline chosen by the candidate may request the candidate to present additional documents.
5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in section 1 point 2 letters a-c.
6. In the case of a beneficiary of the "Diamond Grant" programme, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c, regardless of the candidate's results in these criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b)-(e) is the arithmetic mean of the points awarded by individual members of the qualification team, rounded up to one decimal place, and may not be higher than the maximum value specified for a given criterion.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the end of the qualification procedure, the qualification team immediately submits to the admission committee the completed and signed documents referred to in § 3 section 11 item 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and their scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date, place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 shall be provided to the candidates by e-mail to the e-mail address indicated in the IRK system by 23 August 2024.
3. The interview can be conducted on-site or remotely using commonly available online tools. The preferred communicator is MS Teams.
4. Before the interview begins, the chairman or secretary of the selection team is obliged to verify the candidate's identity.
5. The interview consists of two parts:
    1) part one – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) Part two – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the initial topic of the doctoral dissertation,
    2) justification of the choice of topic, results of the analysis of the state of knowledge in the field of selected research topics, literature review,
    3) initial definition of the research problem (goal, research questions, hypotheses),
    4) the proposed methodology,
    5) expected results.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the selection committee may commission the qualification team to re-analyze the documents
   and the method of awarding ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the following cases:
    1) meeting the formal requirements referred to in § 6 section 1,
    2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
    3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
    4) obtain a total of at least 55 ranking points, including at least 20 points from the interview.

3. Failure to meet the conditions referred to in paragraph 2 makes it impossible to enter a candidate on the ranking list of candidates even if the limit of places specified for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee draws up a report on the recruitment process, to which it attaches a document called the ranking list of candidates, containing information about candidates pre-qualified for entry on the list of doctoral students.
3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) an interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admission committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2024/2025.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) the candidate's name and surnames,
   2) final result – the sum of ranking points,
   3) designation whether the candidate has been pre-qualified for entry on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should include a justification and be confirmed by the signature of the chairman of the admission committee.

Chapter VII
Admission and refusal of admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after being delivered to the Dean's Office of the Doctoral School no later than by 23 September 2024.
   1) declarations in accordance with the template set out in Appendix No. 7 to the recruitment rules,
   2) a diploma of completion of second-cycle studies, uniform master's degree studies or equivalent obtained on the basis of separate regulations or a certificate of obtaining a master's degree.

2. In special cases, the chairman of the admissions committee may set a deadline for the other candidate to submit the documents referred to in paragraph 1.
3. Failure to meet the requirements set out in paragraph 1 results in the deletion of the candidate from the list of pre-qualified students and a request from the admission committee to the Rector to issue a decision on refusal of admission to the Doctoral School.
4. Candidates who meet the conditions referred to in § 12 section 2 and have not been admitted due to the exhaustion of the limit of places specified for the scientific discipline constitute the reserve group. In the event of vacancies on the list of pre-qualified candidates for the Doctoral School for the academic year 2024/2025 in the scientific discipline chosen by the candidate, these persons may, by the decision of the Rector, be admitted to the Doctoral School in the order resulting from the number of points obtained.
5. The admissions committee immediately informs the candidate about admission in this mode. The provisions of paragraphs 1 and 2 shall apply accordingly, and the declaration referred to in paragraph 1 shall be submitted by the candidate within seven days from the date of providing information about this obligation, otherwise the qualification will expire by operation of law.

§ 15

1. Admission to the Doctoral School takes place by way of entry on the list of doctoral students.
2. Refusal of admission to the Doctoral School takes place by way of an administrative decision of the Rector at the request of the admission committee. The rector's decision may be appealed for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special Recruitment Procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School as part of a special recruitment procedure takes place as a separate competition procedure, except for the limits of places specified in § 1 section 8, the rules of which take into account these recruitment rules and the rules specified for the program, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. Common admission rules, after consultation with representatives of the competent institution or the head of the programme, project, grant or contract, are approved by the chairman of the admission committee
3. Special recruitment procedures for the Doctoral School are conducted by the recruitment committee and qualification teams referred to in § 2 section 1, subject to sections 4 and 5.

4. Meetings of the qualification teams and the recruitment committee as part of the special recruitment procedure may be attended by representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. If the activities of the Admission Committee and Qualification Teams are terminated during the special recruitment procedure, the Rector may extend their activities until the end of the procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2024/2025 only on condition that they ensure, throughout the entire period of education, full funding from doctoral programmes, projects, grants or contracts in the amount of not less than the amount of the scholarship specified in Article 209 section 4 of the Act and a possible increase in the scholarship and co-financing of the costs of using the research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.
8. The period of education referred to in paragraph 6 also includes the period of suspension of education and extension of the deadline for submitting the doctoral dissertation.
9. The condition for admission to the Doctoral School and financing of candidates referred to in paragraph 7 is an agreement specifying the conditions for the implementation, financing and settlement of funds for the financing of doctoral scholarships(s), increase in the amount of the scholarship or scholarships and social security costs incurred by MUT and, possibly, co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Higher Education and Science on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for implementation recruitment should be recruited from among the employees of enterprises and other entities cooperating with the Military University of Technology.
3. By 15 April 2024, the admissions committee shall determine:
   1) schedule of implementation recruitment,
   2) list and templates of documents submitted by the potential supervisor and candidate at each stage of recruitment,
   3) the manner and place or form of submitting documents.

4. Induction recruitment is conducted by the recruitment committee and qualification teams in two stages:
   1) initial stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of documents, payment of the recruitment fee referred to in § 9 section 1 and 2 within the deadline specified in the schedule referred to in section 3 point 1,
   2) submission of documents by the admissions committee to the qualification team competent for the scientific discipline,
   3) Qualification procedure conducted by the qualification team in the scope of:
      a) analysis and evaluation of the topic of the doctoral dissertation submitted by the candidate and the scientific achievements of the potential supervisor,
      b) the candidate meets the formal requirements to:
         - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'DW'
         - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 item 1,
      c) conducting an interview,
      d) awarding ranking points for the criteria referred to in §10 section 1 point 2,
      e) provide the admission committee with the documents referred to in section 3 point 3 together with recommendations for the recruitment committee regarding the candidate's qualifications for the DW programme.
6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in section 5 point 3 letter b, obtain a positive grade referred to in section 5 point 3 letter a and obtain a minimum of 20 points from the interview.
7. Before accepting the protocols of the qualification teams, the Selection Committee may order the Qualification Team to re-conduct the qualification procedure referred to in section 5(a), (b) and (d).
8. The admissions committee draws up a report on the course of the preliminary stage, to which it attachs, in the case of positive acceptance of the candidates, a document called a ranking list, containing information about candidates pre-qualified for entry on the list of doctoral students under the DW programme.
9. On the basis of the admission committee's report from the preliminary stage:
   1) an application is submitted to the minister responsible for higher education and science, hereinafter referred to as the "Minister", through the Integrated System of Services for Science (ZSUN/OSF), to qualify a candidate for participation in the DW programme, or
   2) in the event of failure to meet the requirements referred to in paragraph 6, the candidate receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2024/2025 under the programme.
10. The proposals referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.

11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is posted on the Doctoral School's website and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the preliminary stage and includes:
    1) submission by the candidate of the documents for this stage, specified in section 3 point 2,
    2) the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 14,
    3) preparation of the final protocol of the induction recruitment by the recruitment committee.
13. The Recruitment Committee may, at any stage of the induction recruitment, request the candidate to submit additional documents confirming the fulfillment of the requirements for participation in the DW program.
14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application to participate in the DW programme for the academic year 2024/2025.
15. If the Minister provides information on the failure to qualify the MUT application for participation in the DW programme, the Rector issues a decision on refusal to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final report of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2024/2025 under the DW programme, or
    2) receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2024/2025 under this programme.
17. The candidate's participation in the induction recruitment does not exclude, at their request, participation in the recruitment process for the Doctoral School for the academic year 2024/2025.

Chapter III
Other programmes, projects, grants, contracts

§ 18

1. Special recruitment procedures may also be conducted under other programmes, projects, grants or agreements.
2. Detailed rules of the procedure referred to in paragraph 1 are specified by the admissions committee, at least 14 days before the start of recruitment, taking into account the candidates' compliance with the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or agreement.
3. Qualification procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions apply:
   1) Act
   2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the nostrification of higher education diplomas abroad and confirmation of completion of studies at a specific level (Journal of Laws No. item 1881),
   3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2023, item 775, as amended).

Appendix No. 1
to the Rules of Recruitment to the Doctoral School of the Military University of Technology
for the academic year 2024/2025

Specific rules awarding ranking points

1. Selection teams award ranking points to candidates according to the following criteria:

Criterion	Number of points Ranked	
1. Master's Degree Result	0:÷20	60 points in the case of candidates referred to in § 10 sec. 5 and 6 of the recruitment rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0:÷30	
4. The concept of the doctoral dissertation	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. Detailed rules for awarding ranking points in individual criteria:

1) Master's Degree Result

Result	Number of points Ranked
Very Good with Distinction (5W)	20
very good (5)	15
dobry plus (4+)	10
Good (4)	5
below good (under 4)	0

2) Qualifications and competences of a candidate for education at the Doctoral School in a selected scientific discipline

Specification	Number of ranking points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and attestations confirming the acquisition of qualifications needed in scientific work (postgraduate studies, courses, training, certificate of any foreign language above B2, etc.)	0 ÷ 5

3) Candidate's academic achievements

Specification	Number of ranking points
1) documented scientific publications published in the years 2017-2024, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 15 points for one monograph
b) chapter in a multi-author monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 5 points for one chapter – a total of no more than 10 points
c) scientific publication in journals from the list referred to in Article 267 section 3 of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 15 points.
e) participation in a scientific conference with the presentation of the paper and its publication in peer-reviewed post-conference materials, referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 10 points.
2) documented awards or scholarships	**0 ÷ 15 points**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one award or scholarship
b) obtaining the Rector's award or scholarship	0 ÷ 3 points
c) distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 points**
1. distinction in the competition for the best student thesis as part of the activities of the Student Research Centre	0 ÷ 3 points;
2. distinction for the speech at the KNS seminar	0 ÷ 2 points
4) documented participation in research projects - based on statements of the principal investigators	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF format*
2. *If the sum of the points in the sub-criteria exceeds the maximum value for that criterion, the maximum number of points for that criterion will be awarded to you*

4) The concept of the doctoral dissertation

Specification	Number of ranking points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the topic of the dissertation and the justification of its selection, definition of the research problem, purpose, research questions, hypotheses, methodology and presentation of the current state of research in the field of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Number of ranking points
1) evaluation of the presentation of the concept of the doctoral dissertation in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) proposed methodology, d) novelty and originality of the issues raised, e) to present the state of research in the field of project and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct a scientific discussion, including coherence and clarity of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

(academic title/degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

(university/organizational unit)

STATEMENT

I declare that if you are accepted:

(name and surname of the candidate)

to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2024/2025, I give my preliminary consent to scientific supervision and to perform the function of a supervisor within the research topic:

(research topics)

…….
(date)

……..
(signature of the potential supervisor)

Appendix No. 3
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

(name and surname of the candidate)

(scientific discipline)

The concept of the doctoral dissertation[1]

……..
legible signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, the definition of: the research problem, the goal, the research questions, the hypotheses, the methodology and the presentation of the current state of research in the field of the adopted subject matter - **max. 5000 characters without spaces,** Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of recruitment to the Doctoral School of the Military University of Technology
for the academic year 2024/2025.

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. BASIC DATA

1. Completed second-cycle (master's) studies

1)	Name of the university	
2)	field of study	
3)	Completion Score	
4)	year of completion	
5)	Title of the diploma thesis	
6)	name and surname of the head of the diploma thesis	

2nd Do you have a PhD degree? If <u>so</u>, please attach a copy of your doctoral diploma or provisional certificate – *<u>attachment no. 1</u>*

3rd Have you had or are you initiating doctoral proceedings or proceedings for awarding a doctoral degree? If so, please provide the university/institute and scientific discipline and the topic of the dissertation.

4th Have you been or are you a participant of doctoral studies (third-cycle studies)? If <u>so</u> , please provide the university/institute, scientific discipline, year of commencement - year of completion

5th Have you been or are you a doctoral student at a doctoral school? If <u>so</u> , please provide the name of the doctoral school, scientific discipline, date of beginning and end of education

6. Current employment

(name of the workplace, city, position held, status – professional soldier, police officer, prison service officer, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1st Trips abroad and individual studies:

1) **mobility under programs, e.g. Erasmus** – ***Annex 2***

(name of the programme, date of departure, semester of study, host university, country)

2) **Foreign internships** – ***Appendix No. 3***

(name of the traineeship, date, semester of study, host institution, country)

3) **Individual studies - *Appendix No. 4***

(semester(s) of study, level of study)

2nd Certificates and attestations confirming the acquisition of qualifications necessary for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3rd Document certifying knowledge of a foreign language at the level of language proficiency above B2 - *Appendix No. 6*[1]

(name of certificate/attestation)

4th Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Appendix No. 7*[2]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1st Publishing activities in the years 2017 - 2024[3]:

1) monograph from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 8***

(author(s), title, publisher, year of publication, number of points)

[1] documents confirming knowledge of any foreign language at the level above B2, e.g. C1, C2, above SPJ 3333

[2] documents referred to in § 6 section 6 points 1-3

[3] in the case of:

- the monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, a title page and an abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

2) chapter in a multi-author monograph, from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 9***

(author(s), title, title of the monograph, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267 (3) of the Act - ***Appendix No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267 section 3 of the Act - ***Appendix No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication
in peer-reviewed post-conference materials, in the list referred to in Article 267 (3) of the Act - ***Appendix No. 12***

(name of the conference, date, place, topic of the presentation, author(s)

2. Awards, scholarships obtained

1) awards or scholarships of the minister responsible for higher education and science or the Minister of National Defence – ***Appendix 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***Appendix No. 14***

(name of the award or scholarship, date of award)

3) Distinction for the best diploma thesis – ***attachment no. 15***

(bachelor's/master's thesis, date of award)

4) Other awards for research activity – ***Appendix 16***

(title of the award, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

1) distinction in the competition for the best student thesis as part of the activities of the Committee – ***Appendix No. 17***

(topic of the thesis, date of award)

2) distinction for the presentation at the SCS seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution where the project is implemented	Academic title/degree name and surname Manager Project	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the appendix to the point/subsection of the Questionnaire should contain confirmation of all information indicated in this point/subsection,
- attachments should contain confirmations of awards, scholarships, distinctions in the form of scans of diplomas, certificates, decisions,
- Confirmation of the candidate's participation in research projects is a certificate from the principal investigator, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, date	*signature of the candidate*

Appendix No. 5
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

List
documents confirming knowledge of English
at least B2 level

In the recruitment procedure to the Doctoral School of MUT, the candidate's documents confirming his/her knowledge of English at least at the B2 level on the global scale of language proficiency according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)" are accepted:

1. Diplomas with a graphic sign indicating level 6 or 7. The Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language taught during the studies was English and the learning outcomes were achieved for English.
2. Information in the supplement to the diploma of graduation that you have passed the English language exam at least at B2 level.
3. Diplomas in English Philology.
4. Certificate confirming the knowledge of a foreign language issued by the National School of Public Administration as a result of a linguistic verification procedure.
5. Certificates confirming the achievement of at least the level of SPJ 3333 in English according to the NATO Standardization Agreement STANAG 6001.
6. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
7. A document issued abroad recognized as equivalent to a secondary school-leaving certificate if the language of instruction was English.
8. International Baccalaureate Diploma or European Baccalaureate Diploma.
9. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
10. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the qualifications of a sworn translator in another Member State of the European Union, a member state of the European Free Trade Association (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
11. Certyfikaty odpowiadające poziomowi co najmniej B2 wydane przez instytucje stowarzyszone w Association of Language Testers in Europe (ALTE) oraz Educational Testing Service (ETS), European Consortium for the Certificate of Attainment in Modern Languages (ECL); City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute, Edexcel, Pearson

Language Tests, Pearson Language Assessments; Education Development International (EDI), London Chamber of Commerce and Industry Examinations Board; University of Cambridge ESOL Examinations, British Council, IDP IELTS Australia; telc GmbH, WBT Weiterbildungs-Testsysteme GmbH; uczelnie zrzeszone w Stowarzyszeniu Akademickich Ośrodków Nauczania Języków Obcych SERMO.

12. Other certificates, attestations, diplomas not listed above – if they are approved by the Head of the Foreign Language Centre of the Military University of Technology.

Appendix No. 6
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

Information clause

Pursuant to Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of personal data processing, who can be contacted via the following e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for recruitment purposes to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes, as well as for the purpose of pursuing and defending against possible claims.
4. The data provided will be processed on the basis of Article 6(1)(c) and (e) of the GDPR, i.e. in order to comply with a legal obligation to which the Controller is subject and when the processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the Controller.
5. In the case of awarding an increased scholarship amount, data of special categories in the form of a person's health condition (including disability) will be processed on the basis of Article 9(2)(b), i.e. the processing is necessary for the fulfilment of duties and performance by the Administrator in the field of labour law, social security and social protection.
6. Providing data is voluntary, but necessary to achieve the purposes for which it was collected. Failure to provide them will make it impossible to conduct recruitment and admission to the first year of education at the Doctoral School.
7. Personal data will not be made available to other recipients, except for the minister competent for higher education and science, the Minister of National Defence and cases provided for by law.
8. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
9. You have the right to access your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
10. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
11. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the

President of the Office for Personal Data Protection, if they believe that the processing of personal data violates the generally applicable regulations in this respect.

I confirm that I have read and acknowledge the above information.

....

city, date legible signature of the candidate

Appendix No. 7
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **October 1, 2024.**:

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology will be the only doctoral school where I will carry out education;
2. I have/do not have* a doctoral degree[1];
3. I have/do not have* the certificate(s):[2]
   1) on disability*,
   2) on the degree of disability* referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2021, item 573, as amended).

……..
legible signature of the candidate

Attachments:

1. ……
2. ……

**- delete as appropriate*

[1] in the case of holding a doctoral degree, a copy of the diploma on awarding the doctoral degree or a provisional certificate should be attached
[2] If you have a certificate, you must attach a copy of it

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 8/WAT/2025 of 27 February 2025

on the determination of the "Rules of recruitment"
to the Doctoral School of the Military University of Technology
for the academic year 2025/2026

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2024, item 1571, as amended), in connection with § 21 section 1 point 27 of the Statute of the Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), it is hereby resolved, as follows:

§ 1

The "Rules of recruitment" to the Doctoral School of the Military University of Technology for the academic year 2025/2026" *are hereby established,* constituting an attachment to the resolution.

§ 2

The resolution shall enter into force on the date of its adoption.

President of the Senate

gen. bryg. prof. dr hab. inż. Przemysław Wachulak

Attachment
to Resolution No. 8/WAT/2025 of the Senate of the Military University of Technology
of 27 February 2025 r.

Recruitment rules
to the Doctoral School of the Military University of Technology for the academic year 2025/2026

Section I
General

§ 1

1. The Doctoral School of the University of Technology, referred as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2025/2026 in the following scientific disciplines:
   1) automation, electronics, electrical engineering and space technologies,
   2) information and telecommunication technology,
   3) civil engineering, geodesy and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) security studies,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School takes place through a competition in accordance with these Recruitment Rules for the Doctoral School of the Military University of Technology for the academic year 2025/2026, hereinafter referred to as the "Recruitment Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines within which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as for Polish citizens, considering the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2024, item 1571, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for sending professional soldiers to the Doctoral School in the service mode are regulated by the provisions of the Act of 11 March 2022 on the Defence of the Homeland (i.e. Journal of Laws of 2024, item 248, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places in the Doctoral School is determined by the Rector by 30 May 2025, at the request of the director of the Doctoral School, hereinafter referred to as the "director".
9. By 30 May 2025, the Councils of Scientific Disciplines will establish lists of potential supervisors along with the thematic scope of the research.
10. The Councils for Scientific Disciplines may amend the lists referred to in paragraph 9 by 31 July 2025.
11. The resolutions referred to in paragraphs 9 and 10 shall be immediately forwarded by the Chairman of the Scientific Discipline Council to the Director.

Section II
Selection committee and selection teams

§ 2

1. To conduct the recruitment procedure to the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Admission Committee of the Doctoral School, hereinafter referred to as the "Admission Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "Qualification Team".
2. The admissions committee and qualification teams are appointed by the Rector for the period from 15 April 2025 to 14 April 2026.
3. At the request of the chairperson of the admissions committee or the chairman of the qualification team, the Rector may appoint new members or dismiss the appointed members of the admissions committee or the qualification team, respectively.
4. Work in the recruitment committee and in the qualification, team is remunerated. In the decision referred to in paragraph 1, the Rector lays down the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The admissions committee consists of:
   1) chairman – the director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the head,
   4) secretary – head of the Dean's Office of the Doctoral School.
2. By 21 March 2025, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 item 1 shall provide the director with the data of the representatives referred to in paragraph 1 item 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity within the scope of this scientific discipline.
3. A representative appointed by the Doctoral Students' Government may participate in the deliberations of the Admission Committee as an observer.
4. Administrative support for the recruitment committee is provided by the Dean's Office of the Doctoral School.
5. The chairman of the admissions committee convenes meetings of the admissions committee and chairs its meetings.
6. Committee meetings may be held remotely. Decisions on the form of the meeting are made by the chairman of the admissions committee.
7. Meetings of the admissions committee are recorded. The minutes are signed by the chairman of the admissions committee and the members of the committee participating in the meeting, subject to paragraph 9.
8. In the case of a committee meeting conducted remotely, the minutes are signed only by the chairman of the admission committee.
9. In the absence of the chairman, the committee meeting is convened and chaired by a committee member authorized by the chairman.
10. Tasks of the admissions committee:
    1) supervision over the recruitment and qualification procedure,

2) analysis of the correctness and completeness of documents submitted by candidates,
3) preparation and submission to qualification teams:
    a) candidates' documents,
    b) the template of the protocol,
    c) individual assessment cards of the candidate,
4) setting the dates of interviews within individual scientific disciplines,
5) setting individual dates for interviews and notifying candidates,
6) determining, based on the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified for entry on the list of doctoral students,
7) publication on the Doctoral School's website of the list of pre-qualified persons and, after verification of the documents referred to in § 14 section 1, the list of persons admitted to the Doctoral School within individual scientific disciplines,
8) preparation of a decision on refusal of admission to the Doctoral School.

§ 4

1. The qualification team for a scientific discipline includes:
    1) chairman
    2) two members at least,
    3) secretary.
2. By 21 March 2025, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 section 1 shall submit to the director the data of candidates for:
    1) the chairperson and members of the team – from among academic teachers holding the academic title of professor or the academic degree of doctor “habilitowany” conducting scientific or didactic activity in the field of this scientific discipline,
    2) secretary - from among the employees of the faculty related to the scientific discipline appropriate for the Council.
3. Tasks of the qualification teams:
    1) analysis of candidates' documents submitted by the recruitment committee,
    2) analysis and assessment of the relationship between the candidate's completed master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
    3) analysis of qualifications and competences as well as scientific achievements of candidates and awarding ranking points in accordance with point 2 subsections 1-3 of Appendix No. 1 to the recruitment rules,
    4) analysis of the concept of the doctoral dissertation of the candidates and awarding ranking points in accordance with point 2 subsection 4 of Annex 1 to the recruitment rules,
    5) conducting an interview and awarding ranking points in accordance with point 2 subsection 5 of Appendix No. 1 to the recruitment rules.
    6) determining the general, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the recruitment rules,
    7) Submission of the protocol to the Recruitment Committee along with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:

a) pre-qualification of candidates for entry on the list of doctoral students,
b) a proposal to change the limit of places for a scientific discipline,
c) establishing a reserve list of candidates,

8) preparing information for the admissions committee on the course of the qualification procedure in the case of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and the members of the selection team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairman of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the chairman of the qualification team of any circumstances that may affect his or her impartiality and objectivity in the assessment of candidates for the Doctoral School.
3. A member of the selection team is excluded from the candidate's assessment in particular if:
   1) provided the candidate with the statement referred to §6 section 1 point 3,
   2) he was the supervisor of the candidate's master's thesis;
   3) is the candidate's superior or is in another employment relationship with the candidate;
   4) the candidate is or was his/her spouse or is a relative or in-law to the second degree, or remains or has been cohabiting with a member of the admissions committee;
   5) the candidate is or was a person related to a member of the committee by adoption;
   6) there are other objective circumstances that may give rise to justified concerns as to the impartiality and objectivity of the candidate's assessment.
4. The chairperson may exclude himself from the evaluation of a candidate in the cases referred to in paragraph 3.
5. If at least two members of the qualification team are excluded from the candidate's evaluation, the chairperson applies to the Rector to appoint new members of the team.
6. The exclusion of a member of the qualification team from the assessment of a given candidate is recorded in the report of the selection team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 who:
   1) hold a master's degree, a master's degree in engineering or an equivalent title,
   2) have a documented knowledge of English at a level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 5 – the template of the declaration is included in Annex 8 to the admission rules,
   3) obtain a statement from a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is included in Appendix No. 2 to the recruitment rules.
2. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may be applied for admission by graduates of first-cycle studies or students who have completed the third year of long-cycle studies who meet the requirements referred to in section 1 points 2 and 3.
3. Confirmation of English language proficiency at least B2 level are only the documents indicated in Appendix No. 5 to the recruitment rules.
4. In the absence of a master's degree diploma due to waiting for its issuance, the candidate is obliged to present a certificate from the university confirming the award of a master's degree.
5. The certificate is not required for native English speakers.
6. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at B2 level.
7. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of the Polish language, i.e.:
   1) have completed a one-year preparatory course to study in Polish in units designated by the minister responsible for higher education, or
   2) have a certificate of proficiency in Polish issued by the State Commission for the Certification of Proficiency in Polish as a Foreign Language or
   3) have completed studies in Poland in a field of study conducted in Polish, or
   4) during the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.
8. If the Master's degree diploma was issued in a language other than Polish or English, the candidate shall attach a certified translation into Polish.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Online Registration of Candidates (IRK) system, completion of forms, uploading electronic versions of documents, payment of the recruitment fee - **1-17 August 2025,**
   2) Admission procedure - **18 August - 12 September 2025,** including interviews with candidates within the following scientific disciplines:
      - Automation, electronics, electrical engineering and space technologies - **10-11 September 2025**,
      - Technical informatics and telecommunications – **September 8-9, 2025**;
      - Civil engineering, geodesy and transport - **10 September 2025**;
      - Materials engineering - **September 11, 2025**;
      - Mechanical engineering - **September 10-12, 2025**;
      - Security sciences - **September 10-12, 2025**;
      - Chemical sciences - **September 12, 2025**
   3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 17 September 2025**,
   4) issuance of an administrative decision on refusal of admission to the Doctoral School to candidates not qualified for entry on the list of doctoral students **– 23-25 September 2025**,
   5) submission by candidates pre-qualified for entry on the list of doctoral students of the documents referred to in § 14 section 1 – **17-23 September 2025,**
   6) announcement of the list of those admitted to the Doctoral School **- September 25, 2025**
2. The Admission Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2025, subject to paragraph 3
3. In the case of to many candidates, changes to the deadlines for the activities referred to in paragraph 1(2)-(6) may be introduced until 20 August 2025.
4. The lists referred to in section 1 points 3 and 6 are published on the Doctoral School's website.

Chapter III
Registration and submission

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) read these recruitment rules,
   2) preparation of electronic versions of the documents referred to paragraph 4,
   3) select a potential supervisor and the proposed scope of research from the list referred to § 1 section 9, hold an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtain his/her signature on the statement - a template of the statement is included in Appendix 2 to the recruitment rules.

2. Registration of candidates to the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the Doctoral School's website and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions of the following documents (pdf format) to the IRK system, subject to sections 5 and 6:
   1) application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the award of a master's degree, a master's degree in engineering or an equivalent title,
   3) a supplement to the Master's Diploma or another document confirming the course of study,
   4) declaration of the potential supervisor – according to the template included in Appendix 2 to the recruitment rules,
   5) concept of the doctoral dissertation – according to the template included in Appendix 3 to the recruitment rules,
   6) information questionnaire with attachments - according to the template included in Appendix 4 to the recruitment rules,
   7) a declaration of English language proficiency at least B2 – according to the template included in Appendix 8 to the recruitment rules,
   8) curriculum vitae (CV),
   9) a signed information clause regarding the processing of personal data – according to the template included in Appendix No. 6 to the recruitment rules.
5. Candidates, beneficiaries of the "Diamond Grant" program, in addition to the documents
   referred to in paragraph 4, submit a document confirming the receipt of the "Diamond Grant".
6. The candidates referred to in § 6 section 2 submit:
   1) documents referred to in section 4 points 1 and 4-9,
   2) a diploma confirming the award of an engineer's or bachelor's degree or a certificate of completion of the third year of long-cycle master's degree studies,
   3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming the award of a second-degree qualification outside Polish shall additionally submit a translation of the diploma prepared by a sworn translator, subject to § 6 section 7. To recognize a diploma as entitling to undertake education at the Doctoral School, the provisions of Articles 326 and 327 of the Act apply.
8. If the documents referred to in paragraph 4 are not submitted, the admission committee calls the candidate to complete them within 7 days from the date of sending the request to the candidate's e-mail address indicated in the IRK system. Failure to complete the documents within the set deadline will result in the candidate's not being admitted to the qualification procedure.

Chapter IV
Application fee

§ 9

1. The amount of the recruitment fee to the Doctoral School is determined by the Rector by 30 May 2025.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **by 18 August 2025.**
3. In a particularly justified case, the candidate may, by 5 August 2025, submit an application to the Dean's Office of the Doctoral School to the Rector for exemption from the application fee. The Rector makes a decision within 7 days from the date of submitting the application.
4. In the event of refusal to exempt from the fee, the candidate is obliged to pay the application fee within 7 days of providing this information.
5. If the payment is not made within the time limit referred to in paragraph 2 or the application referred to in paragraph 3 is not submitted or the deadline referred to in paragraph 4 expires, the candidate is not subject to the qualification procedure.
6. A candidate is entitled – at his/her request – to a refund of the application fee in the case of:
   1) resignation from participation in the qualification procedure before its commencement, i.e. before 18 August 2025,
   2) overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by the qualification team competent for the scientific discipline chosen by the candidate and includes:
   1) analysis and assessment of the relationship between the candidate's completed Master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
   2) awarding ranking points in the following criteria:
      a) the result of completing a master's degree,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards ranking points to candidates in individual criteria on the terms set out in Appendix 1 to the recruitment rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the case of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside of Polish, the qualification team competent for the scientific discipline chosen by the candidate may request the candidate to present additional documents.

5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in section 1 point 2 letters a-c.
6. In the case of a beneficiary of the "Diamond Grant" programme, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c, regardless of the candidate's results in these criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b)-(e) is the arithmetic mean of the points awarded by individual members of the qualification team, rounded up to one decimal place, and may not be higher than the maximum value specified for a given criterion.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the end of the qualification procedure, the qualification team immediately submits to the admission committee the completed and signed documents referred to in § 3 section 10 item 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and their scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date, place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 shall be provided to the candidates by e-mail to the e-mail address indicated in the IRK system by 29 August 2025.
3. The interview can be conducted on-site or remotely using commonly available online tools. The preferred communicator is MS Teams.
4. Before the interview begins, the chairman or secretary of the selection team is obliged to verify the candidate's identity.
5. The interview consists of two parts:
    1) part one – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) Part two – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the initial topic of the doctoral dissertation,
    2) justification of the choice of topic, results of the analysis of the state of knowledge in the field of selected research topics, literature review,
    3) initial definition of the research problem (aim, research questions, hypotheses, subject of the dissertation),
    4) the proposed methodology,
    5) expected results.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the selection committee may commission the qualification team to analyse the documents and the method of awarding ranking points.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the following cases:
   1) meeting the formal requirements referred to in § 6 section 1,
   2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
   3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
   4) obtain a total of at least 55 ranking points, including at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 makes it impossible to enter a candidate on the ranking list of candidates even if the limit of places specified for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee draws up a report on the recruitment process, to which it attaches a document called the ranking list of candidates, containing information about candidates pre-qualified for entry on the list of doctoral students.
3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) an interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision based on the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admission committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to change the limit of places for individual scientific disciplines or to increase the limit of places for the Doctoral School for the academic year 2025/2026.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) the candidate's name and surnames,
   2) final result – the sum of ranking points,
   3) designation whether the candidate has been pre-qualified for entry on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.

10. Any deletions and changes made to the ranking list after it has been signed should include a justification and be confirmed by the signature of the chairman of the admission committee.

Chapter VII
Admission and refusal of admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after being delivered to the Dean's Office of the Doctoral School no later than by 23 September 2025.
   1) declarations in accordance with the template set out in Appendix No. 7 to the recruitment rules,
   2) a diploma of completion of second-cycle studies, uniform master's degree studies or equivalent obtained on the basis of separate regulations or a certificate of obtaining a master's degree.
2. In special cases, the chairman of the admissions committee may set a deadline for the other candidate to submit the documents referred to in paragraph 1.
3. Failure to meet the requirements set out in paragraph 1 results in the deletion of the candidate from the list of those pre-qualified for entry on the list of doctoral students and a request from the admission committee to the Rector to issue a decision on refusal of admission to the Doctoral School.
4. Candidates who meet the conditions referred to in § 12 section 2 and have not been admitted due to the exhaustion of the limit of places specified for the scientific discipline constitute the reserve group. In the event of vacancies on the list of pre-qualified candidates for the Doctoral School for the academic year 2025/2026 in the scientific discipline chosen by the candidate, these persons may, by the decision of the Rector, be admitted to the Doctoral School in the order resulting from the number of points obtained.
5. The admissions committee immediately informs the candidate about admission in this mode. The provisions of paragraphs 1 and 2 shall apply accordingly, and the declaration referred to in paragraph 1 shall be submitted by the candidate within seven days from the date of providing information about this obligation, otherwise the qualification will expire by operation of law.

§ 15

1. Admission to the Doctoral School takes place by way of entry on the list of doctoral students.
2. Refusal of admission to the Doctoral School is made by way of an administrative decision of the Rector at the request of the admission committee. The Rector's decision may be appealed for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School as part of a special recruitment procedure takes place as a separate competition procedure, except for the limits of places specified in § 1 section 8, the rules of which consider these recruitment rules and the rules specified for the program, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. Common admission rules, after consultation with representatives of the competent institution or the head of the programme, project, grant or contract, are approved by the chairman of the admission committee
3. The special recruitment procedure for the Doctoral School is conducted by the admission committee and the qualification teams referred to in § 2 section 1, subject to sections 4 and 5.
4. Meetings of the qualification teams and the recruitment committee as part of the special recruitment procedure may be attended by representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activity of the Admission Committee and qualification teams during the special recruitment procedure, the Rector may extend their activity until the end of the procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2025/2026 only if they ensure, throughout the entire period of education, full funding from doctoral programmes, projects, grants or contracts in the amount not lower than the amount of the scholarship specified in Article 209 section 4 of the Act and a possible increase in the scholarship and co-financing of the costs of using the research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.
8. The period of education referred to in paragraph 7 also includes the period of suspension of education and extension of the deadline for submitting the doctoral dissertation.
9. The condition for admission to the Doctoral School and financing of candidates referred to in paragraph 7 is an agreement specifying the conditions for the implementation, financing and settlement of funds for the financing of doctoral scholarships(s), increase in the amount of the scholarship or scholarships and social security costs incurred by MUT and, possibly, co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" program, hereinafter referred to as the "DW Program" is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Science on the establishment of the "Implementation Doctorate" program and the call for applications.
2. Candidates for the DW programme should be recruited from among the employees of companies and other entities cooperating with the Military University of Technology.
3. The Recruitment Committee, after publishing the Communication referred to in paragraph 1, determines:
   1) recruitment schedule,
   2) list and templates of documents submitted by the potential supervisor and candidate at each stage of recruitment,
   3) the manner and place or form of submitting documents.
4. Recruitment for the DW program is conducted by the admissions committee and qualification teams in two stages:
   1) initial stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee referred to in § 9 section 1 to an individual bank account generated for each candidate by the IRK system within the deadline specified in the schedule referred to in section 3 item 1,
   2) submission of documents by the admissions committee to the qualification team competent for the scientific discipline,
   3) Qualification procedure conducted by the qualification team in the scope of:
      a) analysis and evaluation of the topic of the doctoral dissertation submitted by the candidate and the scientific achievements of the potential supervisor,
      b) the candidate meets the formal requirements to:
         - participation in the DW program,
         - education at the Doctoral School of the Military University of Technology in accordance with § 6 section 1 and § 10 section 1 point 1,
      c) conducting an interview,
      d) awarding ranking points for the criteria referred to §10 section 1 point 2,
      e) provide the admission committee with the documents referred to section 3 point 3 together with recommendations for the recruitment committee regarding the candidate's qualifications for the DW programme.
6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in section 5 point 3 letter b, obtain a positive grade referred to in section 5 point 3 letter a and obtain a minimum of 20 points from the interview.

7. Before accepting the protocols of the qualification teams, the Selection Committee may order the Selection Team to re-conduct the qualification procedure referred to in section 5(3)(a), (b) and (d).
8. The admissions committee draws up a report on the course of the preliminary stage, to which it attachs, in the case of positive acceptance of the candidates, a document called a ranking list, containing information about candidates pre-qualified for entry on the list of doctoral students under the DW programme.
9. On the basis of the admission committee's report from the preliminary stage:
   1) an application is submitted to the Minister of Science to qualify a candidate for participation in the DW programme through the Integrated System of Services for Science (ZSUN/OSF), or
   2) in the event of failure to meet the requirements referred to in paragraph 6, the candidate receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2025/2026 under the programme.
10. The proposals referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.
11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is posted on the Doctoral School's website and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the preliminary stage and includes:
   1) submission by the candidate of the documents for this stage, specified in section 3 point 2,
   2) the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 14,
   3) preparation by the recruitment committee of the final report on recruitment to the DW program.
13. The admissions committee may, at any stage of the recruitment process for the DW program, request the candidate to submit additional documents confirming the fulfilment of the requirements for participation in the DW program.
14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application to participate in the DW programme for the academic year 2025/2026.
15. If the Minister provides information on the failure to qualify the MUT application for participation in the DW programme, the Rector issues a decision on refusal to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final report of the recruitment committee, the candidate:
   1) is entered on the list of doctoral students of the Doctoral School for the academic year 2025/2026 under the DW programme, or
   2) receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2025/2026 under this programme.
17. The candidate's participation in the recruitment process for the DW programme does not exclude, at his/her request, participation in the recruitment process for the Doctoral School for the academic year 2025/2026.

Chapter III
Other programmes, projects, grants, contracts

§ 18

1. Special recruitment procedures may also be conducted under other programmes, projects, grants or agreements.
2. Detailed rules of the procedure referred to in paragraph 1 are specified by the admissions committee, at least 14 days before the start of recruitment, considering the candidates' compliance with the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or agreement.
3. Qualification procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview considering the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions apply:
   1) Act
   2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the nostrification of higher education diplomas abroad and confirmation of completion of studies at a specific level (Journal of Laws No. item 1881),
   3) of the Act of 14 June 1960. The Code of Administrative Procedure (i.e. Journal of Laws of 2024, item 572, as amended).

Appendix No. 1
to the Rules of Recruitment to the Doctoral School of the Military University of Technology
for the academic year 2025/2026

Specific rules awarding ranking points

1. Selection teams award ranking points to candidates according to the following criteria:

Criterion	Number of points Ranked	
1. Master's Degree Result	0:÷20	60 points in the case of candidates referred to in § 10 sec. 5 and 6 of the recruitment rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0:÷30	
4. The concept of the doctoral dissertation	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. Detailed rules for awarding ranking points in individual criteria:

1) Master's Degree Result

Result	Number of points Ranked
Very good with distinction (5W)	20
very good (5)	15
good plus (4+)	10
good (4)	5
below good (under 4)	0

2) Qualifications and competences of a candidate for education at the Doctoral School in a selected scientific discipline

Specification	Number of ranking points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and attestations confirming the acquisition of qualifications needed in scientific work (postgraduate studies, courses, training, certificate of any foreign language above B2, etc.)	0 ÷ 5

3) Candidate's academic achievements

Specification	Number of ranking points
1) documented scientific publications published in the years 2018-2025, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 15 points for one monograph
b) chapter in a multi-author monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 5 points for one chapter – a total of no more than 10 points
c) scientific publication in journals from the list referred to in Article 267 section 3 of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 15 points.
e) participation in a scientific conference with the presentation of the paper and its publication in peer-reviewed post-conference materials, referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 10 points.
2) documented awards or scholarships	**0 ÷ 15 points**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one award or scholarship
b) obtaining the Rector's award or scholarship	0 ÷ 3 points
c) distinction for the best diploma thesis	0 ÷ 2 points
d) other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 points**
1. distinction in the competition for the best student thesis as part of the activities of the Student Research Centre	0 ÷ 3 points;
2. distinction for the speech at the KNS seminar	0 ÷ 2 points
4) documented participation in research projects - based on statements of the principal investigators	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF format*
2. *If the sum of the points in the sub-criteria exceeds the maximum value for that criterion, the maximum number of points for that criterion will be awarded to you*

4) The concept of the doctoral dissertation

Specification	Ranking points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the topic of the dissertation and the justification of its selection, definition of the research problem, purpose, research questions, hypotheses, methodology and presentation of the current state of research in the field of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Ranking points
1) evaluation of the presentation of the concept of the doctoral dissertation in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) proposed methodology, d) novelty and originality of the issues raised, e) to present the state of research in the field of project and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct a scientific discussion, including coherence and clarity of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(academic title/degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

STATEMENT

I declare that if a candidate will be admitted*:

(name and surname of the candidate)

to the Doctoral School of the Military University of Technology for the academic year 2025/2026, I agree to be a scientific supervisor within the research topic:

(research topics)

At the same time, I declare that:

1) I was not the supervisor of 4 doctoral students who were removed from the list of doctoral students due to a negative result of the mid-term evaluation,
2) I did not supervise the preparation of the dissertation by at least 2 persons applying for a doctoral degree who did not receive positive reviews referred to in Article 191 section 1 of the Act.

……. ……..
(date) *(signature of the potential supervisor)*

* delete as appropriate

Appendix No. 3
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(name and surname of the candidate)

(scientific discipline)

The concept of the doctoral dissertation[1]

……..
signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, the definition of: the research problem, the purpose, the research questions, the hypotheses, the subject of the dissertation methodology and the presentation of the current state of research in the field of the adopted subject matter - **max. 5000 characters without spaces,** Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of recruitment to the Doctoral School of the Military University of Technology
for the academic year 2025/2026.

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. BASIC DATA

1. Completed second-cycle (master's) studies

1)	Name of the university	
2)	field of study	
3)	final score	
4)	year of completion	
5)	Title of the diploma thesis	
6)	name and surname of the head of the diploma thesis	

2. Do you have a PhD degree? If so, please attach a copy of your doctoral diploma or provisional certificate – *attachment no. 1*

3. Have you had or are you initiating doctoral proceedings or proceedings for awarding a doctoral degree? If so, please provide the university/institute and scientific discipline and the topic of the dissertation.

4. Have you been or are you a participant of doctoral studies (third-cycle studies)? If so, please provide the university/institute, scientific discipline, year of commencement - year of completion

5. Have you been or are you a doctoral student at a doctoral school? If so , please provide the name of the doctoral school, scientific discipline, date of beginning and end of education

6. Current employment

(name of the workplace, city, position held, status – professional soldier, police officer, prison service officer, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1. Trips abroad and individual studies:

1) mobility under programs, e.g. Erasmus – *Annex 2*

(name of the programme, date of departure, semester of study, host university, country)

2) foreign internships – *Appendix No. 3*

(name of the traineeship, date, semester of study, host institution, country)

3) individual studies - *Appendix No. 4*

(semester(s) of study, level of study)

2. Certificates and attestations confirming the acquisition of qualifications necessary for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3. Document certifying knowledge of a foreign language at the level of language proficiency above B2 - *Appendix No. 6*[1]

(name of certificate/attestation)

4. Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Appendix No. 7*[2]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1. Publication activities in the years 2018 - 2025[3]:

1) monograph from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 8***

(author(s), title, publisher, year of publication, number of points)

[1] documents confirming knowledge of any foreign language at a level above B2, e.g. C1, C2

[2] documents referred to in § 6 section 6 points 1-3

[3] in the case of:

- the monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, a title page and an abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

2) chapter in a multi-author monograph, from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 9***

(author(s), title, title of the monograph, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267 (3) of the Act - ***Appendix No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267 section 3 of the Act - ***Appendix No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication in peer-reviewed post-conference materials, in the list referred to in Article 267 (3) of the Act - ***Appendix No. 12***

(name of the conference, date, place, topic of the presentation, author(s)

2. Awards, scholarships obtained

1) awards or scholarships of the minister responsible for higher education and science or the Minister of National Defence – ***Appendix 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***Appendix No. 14***

(name of the award or scholarship, date of award)

3) distinction for the best diploma thesis – ***attachment No. 15***

(bachelor's/master's thesis, date of award)

4) other awards for research activity – ***Appendix No. 16***

(title of the award, date of award)

3. Achievements in the Students' Scientific Club (SSC)

1) distinction in the competition for the best student thesis as part of the activities of the Committee – ***Appendix No. 17***

(topic of the thesis, date of award)

2) distinction for the presentation at the SSC seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4. Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from - to	University, scientific institution where the project is implemented	Academic title/degree name and surname Project Manager	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the appendix to the point/subsection of the Questionnaire should contain confirmation of all information indicated in this point/subsection,
- attachments should contain confirmations of awards, scholarships, distinctions in the form of scans of diplomas, certificates, decisions,
- Confirmation of the candidate's participation in research projects is a certificate from the principal investigator, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, state, date	*signature of the candidate*

Appendix No. 5
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

List
documents confirming knowledge of English
at least B2 level

In the recruitment procedure to the Doctoral School of MUT, the following documents are accepted, confirming the candidate's knowledge of English at least at the B2 level on the scale of global language proficiency according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)":

1. A diploma of graduation containing a graphic sign informing about the 6th or 7th level. The Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language taught during the studies was English and the learning outcomes were achieved for English.
2. Information in the supplement to the diploma of graduation that you have passed the English language exam at least at B2 level.
3. Diploma in English Philology.
4. A certificate confirming the knowledge of English issued by the National School of Public Administration as a result of a linguistic verification procedure.
5. Certificates confirming the achievement of the Standard Language Profile (SPJ) 3232 of English proficiency according to the NATO Standardization Agreement STANAG 6001.
6. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
7. A document issued abroad recognized as equivalent to a secondary school-leaving certificate if the language of instruction was English.
8. International Baccalaureate Diploma or European Baccalaureate Diploma.
9. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
10. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the qualifications of a sworn translator in another Member State of the European Union, a member state of the European Free Trade Association (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
11. Certificates confirming knowledge of English at least at B2 level issued by:
    1) Cambridge Assessment English,
    2) LanguageCert Polska,
    3) Educational Testing Service (ETS),
    4) European Consortium for the Certificate of Attainment in Modern Languages (ECL),
    5) Oxford Test of English (OTE),
    6) Trinity College: Integrated skills in English (ISE),

7) City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute,
8) Pearson Qualifications: Pearson test of English - PTE General, Pearson test of English - PTE Academic, PEIC, LCCI qualifications,
9) Cambridge Assessment English, London Chamber of Commerce and Industry Examinations Board. British Council, IDP IELTS Australia: International English Language, Education Development International (EDI), University of Cambridge, ESOL Examinations,
10) TELC GmbH, WBT Weiterbildungs -Testsysteme GmbH,
11) universities and institutions associated with the Association of Language Testers in Europe (ALTE), the Network of University Language Testers in Europe (NULTE), the Association of Academic Foreign Language Teaching Centres (SERMO).

Appendix No. 6
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

Information clause

Pursuant to Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street, Poland.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of personal data processing, who can be contacted via the following e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for recruitment purposes to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes, as well as for the purpose of pursuing and defending against possible claims.
4. The data provided will be processed on the basis of Article 6(1)(c) and (e) of the GDPR, i.e. in order to comply with a legal obligation to which the Controller is subject and when the processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the Controller.
5. In the case of awarding an increased scholarship amount, data of special categories in the form of a person's health condition (including disability) will be processed on the basis of Article 9(2)(b), i.e. the processing is necessary for the fulfilment of duties and performance by the Administrator in the field of labour law, social security and social protection.
6. Providing data is voluntary, but necessary to achieve the purposes for which it was collected. Failure to provide them will make it impossible to conduct recruitment and admission to the first year of education at the Doctoral School.
7. Personal data will not be made available to other recipients, except for the minister competent for science and higher education, the Minister of National Defence and cases provided for by law.
8. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
9. You have the right to access your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
10. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
11. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the

President of the Office for Personal Data Protection, if they believe that the processing of personal data violates the generally applicable regulations in this respect.

I confirm that I have read and acknowledge the above information.

....

city, state, date *signature of the candidate*

Appendix No. 7
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(name and surname of the candidate)

(scientific discipline)

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **October 1, 2025.**:

1. The Doctoral School of the Military University of Technology will be the only doctoral school where I will carry out education;
2. I have/do not have* a doctoral degree[1];
3. I have/do not have* the certificate(s):[2]
   1) on disability*,
   2) on the degree of disability* referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2024, item 44, as amended).

……..
date and legible signature of the candidate

Attachments:

1. ……
2. ……

**- delete as appropriate*

[1] in the case of holding a doctoral degree, a copy of the diploma on awarding the doctoral degree or a provisional certificate should be attached
[2] If you have a certificate, you must attach a copy of it

Appendix No. 8
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(name and surname of the candidate)

(scientific discipline)

STATEMENT

I declare that I have a documented knowledge of English at least at B2 level on the global scale of language proficiency according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)" in accordance with Annex 5 to the Rules of Admissions to the Doctoral School of Military University of Technology for the academic year 2025/2026.

The confirmation of the above-mentioned acquaintance is[1]:

(Diploma Reference, Supplement, Name of Certificate/Attestation)

……..
date and legible signature of the candidate

Attachment[2]:

1. ……

[1] only documents included in Annex 5 to the Rules of recruitment to the Doctoral School of MUT for the academic year 2025/2026 may be indicated

[2] a copy of a document confirming the knowledge of English indicated by the candidate

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology
No. 183/RKR/2019 of 19 July 2019

on the appointment of the Recruitment Committee to conduct the recruitment procedure for the Military University of Technology Doctoral School for the academic year 2019/2020

Pursuant to § 23 section 1 of the Statute of the Military University of Technology, constituting an annex to the Resolution No. 215/III/2012 of the Senate of the Military University of Technology of 29 March 2012 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 1/WAT/2017 of 6 July 2017), in connection with § 2 section 1 of the Annex to the Resolution No. 35/WAT/2019 of the Senate of the Military University of Technology of 30 May 2019 on the determination of the rules of recruitment to the Doctoral School of the Military University of Technology. academic year 2019/2020, it is decided as follows:

§ 1

1. The Recruitment Committee is hereby appointed to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2019/2020, composed of:

1. chairman:
    1. Piotr Zalewski, PhD, Eng. – Director of the Doctoral School;
2. Deputy Chairman:
    1. Dariusz Podbielski, PhD – Deputy Director of the Doctoral School;
3. Members representing scientific disciplines:
    1. Mechanical Engineering

1. Prof. Jerzy Małachowski;
2. Dr Hab. Inż. Zbigniew Leciejewski;
    1. Automation, Electronics and Electrical Engineering

3. Prof. Jan Jabczyński;
4. Mateusz Pasternak, PhD, DSc, Eng.;
    1. Civil Engineering & Transportation

5. Prof. dr Hab. inż. Adam Stolarski;
6. Col. Prof. Michał Kędzierski
    1. Technical Informatics and Telecommunications

7. Kazimierz Worwa, PhD, DSc, Eng.;
8. Dr Hab. Inż. Andrzej Chojnacki;
    1. Materials Engineering

9. Prof. Tomasz Czujko;
10. Paweł Perkowski, PhD, DSc, Eng.;

    1. Chemical Sciences

11. Prof. Stanisław Cudziło;
12. Prof. dr Hab. Inż. Jerzy Choma;
    1. Security Sciences
13. Colonel Szymon Mitkow, PhD;
14. through. Dr Hab. Marcin Górnikiewicz;
15. secretary:
16. Elżbieta Rąpała, MA (SDR).

§ 2

1. The Chancellor, for participation in the work of the commission referred to in § 1, shall ensure that WAT employees are paid additional remuneration, provided that:

1. professional soldiers – by awarding a discretionary award on the terms set out in military regulations;
2. other employees of the Military University of Technology - by granting, at the request of the head of the relevant organisational unit, a task-based allowance in the amount of up to 40% of the sum of the basic salary and functional allowance of a given employee,
3. The remuneration referred to in paragraph 1 shall be paid after the completion of the work of the committee referred to in § 1, on the basis of a list prepared by the Dean's Office of the Doctoral School of the Military University of Technology, upon receipt of applications from the heads of the relevant organisational units.

§ 3

The Recruitment Committee, composed of the composition specified in § 1, operates until 15 October 2019 .

§ 4

The decision enters into force on the day of signing.

Rector

/--/ Brig. Gen. Prof. Tadeusz SZCZUREK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology

No. 104/RKR/2020 of 13 March 2020[1]

on the appointment of the Recruitment Committee to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2020/2021

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019), in connection with § 2 section 1 of the Annex to the Resolution No. 123/WAT/2020 of the Senate of the Military University of Technology of 27 February 2020 on the determination of the rules of recruitment to the WAT Doctoral School for the academic year 2020/2021, it is decided as follows:

§ 1

1. The Recruitment Committee is hereby appointed to conduct the recruitment procedure for the Military University of Technology Doctoral School for the academic year 2020/2021, composed of:
   1) chairman:
      - Piotr Zalewski, PhD, Eng. – Director of the Doctoral School;
   2) Members representing scientific disciplines:

   Automation, Electronics and Electrical Engineering
      - Jan Jabczyński, PhD, DSc, Eng.,
      - Waldemar Żendzian;
      - Dariusz Laskowski, PhD, DSc, Eng.,
      - Mateusz Pasternak, PhD, DSc, Eng.,

   Technical Informatics and Telecommunications
      - Kazimierz Worwa, PhD, DSc, Eng.,
      - Zbigniew Zieliński, PhD, DSc, Eng.,
      - Jerzy Łopatka, PhD, DSc, Eng.;

[1] The decision was amended by the decision of the Rector of the Military University of Technology No. 296/RKR/2020 of 4 September 2020 amending the decision on the appointment of the Recruitment Committee to conduct the recruitment procedure for the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2020/2021

Civil Engineering & Transportation

- Janusz Bogusz, PhD, DSc, Eng.,
- prof. dr hab. inż. Adam Stolarski,
- Colonel Krzysztof Pokonieczny, PhD, DSc, Eng.;

Materials Engineering

- prof. Tomasz Czujko, PhD, DSc, Eng.,
- Wiktor Piecek, PhD, DSc, Eng.,
- Paweł Madejczyk, PhD, DSc, Eng.;

Mechanical Engineering

- Prof. Jerzy Małachowski, PhD, DSc, Eng.,
- dr hab. inż. Stanisław Kachel,
- Colonel Marek Rośkowicz, PhD, DSc, Eng.,
- dr hab. inż. Piotr Rybak, PhD, DSc, Eng.,

Chemical Sciences

- prof. Stanisław Cudziło, PhD, DSc, Eng.,
- prof. dr hab. inż. Jerzy Choma,
- Colonel Przemysław Kula, PhD, DSc, Eng.;

Security Sciences

- Colonel Szymon Mitkow, PhD, DSc, Eng.;
- prof. Dr Hab. Bogusław Jagusiak, PhD, DSc, Eng.;
- Prof. Tadeusz Szczurek, PhD, DSc, Eng.;
- by. dr hab. Marcin Górnikiewicz, PhD, DSc, Eng.;
- Adam Ostanek, PhD, DSc, Eng.;;
- dr hab. Monika Szyłkowska;

3) representative of the Doctoral School:

- Dariusz Podbielski, PhD, Eng.;

4) secretary:

- Elżbieta Rąpała, MA (SDR).

§ 2

1. Persons participating in the work of the committee referred to in § 1 are entitled to a one-off remuneration after the completion of their work, provided that:
2. professional soldiers - at the request of the Director of the Doctoral School on the terms set out in military regulations;
3. other employees of the Military University of Technology - through the application of the Director of the Doctoral School for the granting of a task-based allowance.

§ 3

The Recruitment Committee, composed in § 1, operates until 31 December 2020.

§ 4

The decision enters into force on the day of signing.

Rector

(--) Brig. Gen. Prof. Tadeusz SZCZUREK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology

No. 63/RKR/2021 of 16 March 2021

on the appointment of the Recruitment Committee and Qualification Teams to conduct the recruitment procedure for the Doctoral School of the University of Technology for the academic year 2021/2022

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (he announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019), in connection with § 2 section 1 of the Annex to the Resolution No. 9/WAT/2021 of the Senate of the Military University of Technology of 25 February 2021 on the determination of the rules of recruitment to the WAT Doctoral School for the academic year 2021/2022, it is decided as follows:

§ 1

The following are appointed to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2021/2022:

1. The Recruitment Committee composed of:
   1) chairman:
   - Piotr Zalewski, PhD, Eng., Prof. WAT – Director of the Doctoral School;
   2) Members:
   - Prof. Jan Jabczyński - Automation, Electronics and Electrical Engineering,
   - Ryszard Antkiewicz, PhD, DSc, Eng., Prof. WAT - scientific discipline of technical informatics and telecommunications,
   - Albina Mościcka, PhD, DSc, Eng., Prof. WAT - scientific discipline of civil engineering and transport,
   - Stanisław Jóźwiak, PhD, DSc, Eng., Prof. WAT - scientific discipline of materials engineering,
   - Stanisław Kachel, PhD, DSc, Eng., Prof. WAT - scientific discipline of mechanical engineering,
   - Anna Spadło, PhD, DSc, Eng., Prof. WAT - scientific discipline of chemical sciences,
   - Sławomir Bartosiewicz, PhD, DSc, Prof. WAT - scientific discipline of safety science,
   - Dariusz Podbielski, PhD, Eng. - Deputy Director of the Doctoral School;
   3) Secretary: Elżbieta Rąpała, MA - Head of the Dean's Office of the Doctoral School.
2. Qualification teams of scientific disciplines:

1) The qualification team of the scientific discipline of automation, electronics and electrical engineering is composed of:
   a) Chairman: Colonel Norbert Pałka, PhD, DSc, Eng.,;
   b) Members:
   - Prof. Waldemar Żendzian, PhD, DSc, Eng.,
   - Dariusz Laskowski, PhD, DSc, Eng.,,
   - Mateusz Pasternak, PhD, DSc, Eng., Prof. WAT,
   - secretary: Aneta Bombalska, PhD;
2) The qualification team of the scientific discipline of technical informatics and telecommunications is composed of:
   a) Chairman: Zbigniew Tarapata, PhD, DSc, Eng., Prof. WAT;
   b) Members:
   - Janusz Furtak, PhD, DSc, Eng.,
   - inż. Jan Kelner, PhD, DSc, Eng.,
   - secretary: Anna Krukowska, MA;
3) The qualification team of the scientific discipline of civil engineering and transport is composed of:
   a) Chairman: Colonel Krzysztof Pokonieczny, PhD, DSc, Eng., Prof. WAT;
   b) Members:
   - prof. dr hab. inż. Adam Stolarski,
   - Agnieszka Zwirowicz-Rutkowska, PhD, DSc, Eng., Prof. WAT,
   - Secretary: Sylwia Burdyńska, MSc;
4) The qualification team of the scientific discipline of materials engineering is composed of:
   a) Chairman: Prof. Tomasz Czujko;
   b) Members:
   - Paweł Perkowski, PhD, DSc, Eng.,
   - Colonel Małgorzata Kopytko, PhD, DSc, Eng.,
   - Secretary: Lieutenant Colonel Krzysztof Karczewski, PhD, Eng.,
5) Qualification Team No. 1 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Tadeusz Dziubak, PhD, DSc, Eng.,;
   b) Members:
   - Prof. Jan Godzimirski, PhD, DSc, Eng.,
   - Danuta Miedzińska, PhD, DSc, Eng.,
   - Secretary: Krzysztof Grzelak, PhD;
6) Qualification Team No. 2 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Marek Rośkowicz, PhD, DSc, Eng., Prof. WAT;
   b) Members:
   - Andrzej Typiak, PhD, DSc, Eng.,
   - Jacek Janiszewski, PhD, DSc, Eng.,
   - secretary: Anna Kutyła, MA;
7) The qualification team of the scientific discipline of chemical sciences is composed of:
   a) Chairman: Prof. Marzena Tykarska, PhD, DSc, Eng.,
   b) Members:
   - Przemysław Kula, PhD, DSc, Eng.,
   - Jarosław Puton, PhD, DSc, Eng.;
   - Secretary: Mateusz Szala, PhD;
8) The qualification team of the scientific discipline of safety science is composed of:
   a) chairman: Colonel Szymon Mitkow, PhD;

b) Members:
- Prof. Dr Hab. Bogusław Jagusiak, PhD, DSc, Eng.,
- Prof. Tadeusz Szczurek, PhD, DSc, Eng.,
- Marcin Górnikiewicz, PhD, DSc, Eng.,;
- secretary: Paweł Kawalerski, PhD.

§ 2

1. Persons participating in the work of the recruitment committee and qualification teams referred to in § 1 are entitled to a one-off remuneration, provided that:

1. professional soldiers - at the request of the Director of the Doctoral School on the terms set out in military regulations;
2. other WAT employees - at the request of the Director of the Doctoral School, in accordance with § 14 section 5 and § 34 of the Regulations on the remuneration of WAT employees.

3. The remuneration referred to in paragraph 1 shall be paid after the work of the recruitment committee and qualification teams has been completed.

§ 3

The Recruitment Committee and qualification teams, in the compositions specified in § 1, operate from 16 March 2021 to 15 March 2022.

§ 4

The decision enters into force on the day of signing.

Rector

/--/ Col. Prof. Eng. Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology
No. 124/RKR/2022 of 15 March 2022

on the appointment of the Recruitment Committee and Qualification Teams to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2022/2023

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 2 section 1 of the Annex to the Resolution No. 11/WAT/2022 of the Senate of the Military University of Technology of 24 February 2022 on the determination of the rules of recruitment to the School Doctoral Programme of the Military University of Technology for the academic year 2022/2023, the following is decided:

§ 1

The following are appointed to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2022/2023:

1. The Recruitment Committee composed of:
   1) chairman:
      - Piotr Zalewski, PhD, Eng., Prof. WAT – Director of the Doctoral School;
   2) Members:
      - Prof. Waldemar Żendzian - Scientific Discipline of Automation, Electronics and Electrical Engineering,
      - Janusz Furtak, PhD, DSc, Eng., Prof. WAT - scientific discipline of technical informatics and telecommunications,
      - Albina Mościcka, PhD, DSc, Eng., Prof. WAT - scientific discipline of civil engineering and transport,
      - Wojciech Stępniowski, PhD, DSc, Prof. WAT - Materials Engineering,
      - Stanisław Kachel, PhD, DSc, Eng., Prof. WAT - scientific discipline of mechanical engineering,
      - Anna Spadło, PhD, DSc, Eng., Prof. WAT - scientific discipline of chemical sciences,
      - Colonel Konrad Stańczyk - scientific discipline of security science,
      - Dariusz Podbielski, PhD, Eng. - Deputy Director of the Doctoral School;
   3) Secretary: Elżbieta Rąpała, MA - Head of the Dean's Office of the Doctoral School.
2. Qualification teams of scientific disciplines:

1) The qualification team of the scientific discipline of automation, electronics and electrical engineering is composed of:
   a) Chairman: Mateusz Pasternak, PhD, DSc, Eng.,
   b) Members:
   – Jacek Kwiatkowski, PhD, DSc,
   – Norbert Pałka, PhD, DSc,
   – secretary: Aneta Bombalska, PhD;
2) The qualification team of the scientific discipline of technical informatics and telecommunications is composed of:
   a) Chairman: Col. Jan Kelner, PhD, DSc, Eng.;
   b) Members:
   – Janusz Furtak, PhD, DSc
   – Krzysztof Murawski, PhD, DSc;
   – secretary: Anna Krukowska, MA;
3) The qualification team of the scientific discipline of civil engineering and transport is composed of:
   a) Chairman: Colonel Krzysztof Pokonieczny, PhD, DSc, Eng.;
   b) Members:
   – prof. dr hab. inż. Adam Stolarski,
   – Agnieszka Zwirowicz-Rutkowska, PhD, DSc, Eng.,
   – Secretary: Sylwia Burdyńska, MSc;
4) Zespół kwalifikacyjny dyscypliny naukowej inżynieria materiałowa w składzie:
   a) Chairman: Prof. Tomasz Czujko;
   b) Members:
   – Wiktor Piecek, PhD, DSc, Eng.,
   – Małgorzata Kopytko, PhD, DSc, Eng.,,
   – Secretary: Lieutenant Colonel Krzysztof Karczewski, PhD;
5) Qualification Team No. 1 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Józef Pszczółkowski, PhD, DSc, Eng.;
   b) Members:
   – Prof. Jan Godzimirski, PhD, DSc, Eng.,
   – Danuta Miedzińska, PhD, DSc, Eng.,
   – Secretary: Marcin Wachowski, PhD;
6) Qualification Team No. 2 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Marek Rośkowicz, PhD, DSc, Eng.;
   b) Members:
   – Andrzej Typiak, PhD, DSc, Eng.,
   – Jacek Janiszewski, PhD, DSc, Eng.,
   – secretary: Anna Kutyła, MA;
7) The qualification team of the scientific discipline of chemical sciences is composed of:
   a) chairman: Prof. Marzena Tykarska;
   b) Members:
   – Stanisław Popiel, PhD, DSc, Eng.,
   – Krzysztof Kuśmierek, PhD, DSc, Eng.,
   – secretary: Piotr Harmata, PhD;
8) The qualification team of the scientific discipline of safety science is composed of:
   a) chairman: Colonel Szymon Mitkow, PhD, DSc, Eng.,;
   b) Members:

- prof. Bogusław Jagusiak, PhD, DSc, Eng.,
- prof. Tadeusz Szczurek, PhD, DSc, Eng.,
- Marcin Górnikiewicz, PhD, DSc, Eng.;
- secretary: Paweł Kawalerski, PhD.

§ 2

1. Persons participating in the work of the recruitment committee and qualification teams referred to in § 1 are entitled to a one-off remuneration, provided that:

1. professional soldiers - at the request of the Director of the Doctoral School on the terms set out in military regulations;
2. other WAT employees - at the request of the Director of the Doctoral School, in accordance with § 14 section 5 and § 34 of the Regulations on the remuneration of WAT employees.

3. The remuneration referred to in paragraph 1 shall be paid after the work of the recruitment committee and qualification teams has been completed.

§ 3

The Recruitment Committee and qualification teams, in the compositions specified in § 1, operate from 16 March 2022 to 15 March 2023.

§ 4

The decision enters into force on the day of signing.

Rector

/--/ Col. Prof. Eng. Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology

No. 95/RKR/2023 of 30 March 2023

on the appointment of the Recruitment Committee and Qualification Teams to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2023/2024

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 2 section 1 of the Annex to the Resolution No. 28/WAT/2023 of the Senate of the Military University of Technology of 23 February 2023 on the determination of the rules of recruitment to the Doctoral School of the Military University of Technology for the year Academic Year 2023/2024, it is decided as follows:

§ 1

The following are appointed to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2023/2024:

1. The Recruitment Committee composed of:
   1) chairman:
      - Piotr Zalewski, PhD, Eng., Prof. WAT – Director of the Doctoral School;
   2) Members:
      - Prof. Waldemar Żendzian - scientific discipline of automation, electronics, electrical engineering and space technologies,
      - Colonel Jan Kelner, PhD, DSc, Eng., Prof. WAT - scientific discipline of technical informatics and telecommunications,
      - Albina Mościcka, PhD, DSc, Eng., Prof. WAT - scientific discipline of civil engineering, geodesy and transport,
      - Wojciech Stępniowski, PhD, DSc, Prof. WAT - Materials Engineering,
      - Stanisław Kachel, PhD, DSc, Eng., Prof. WAT - scientific discipline of mechanical engineering,
      - Anna Spadło, PhD, DSc, Eng., Prof. WAT - scientific discipline of chemical sciences,
      - Colonel Konrad Stańczyk - scientific discipline of security science,
      - Dariusz Podbielski, PhD, Eng. - Deputy Director of the Doctoral School;
   3) Secretary: Elżbieta Rąpała, MA - Head of the Dean's Office of the Doctoral School.

2. Qualification teams of scientific disciplines:

1) The qualification team of the scientific discipline of automation, electronics, electrical engineering and space technologies is composed of:
   a) chairman: Prof. Mateusz Pasternak, PhD, DSc, Eng.,
   b) Members:
      - Prof. Andrzej Zając, PhD, DSc, Eng.,
      - Col. Jacek Wojtas, PhD, DSc, Eng.,
      - Secretary: Col. Jacek Wojtas, PhD, DSc, Eng.;
2) The qualification team of the scientific discipline of technical informatics and telecommunications is composed of:
   a) Chairman: Janusz Furtak, PhD, DSc, Eng.;
   b) Members:
      - Maciej Kiedrowicz, PhD, DSc, Eng.,
      - Janusz Dudczyk, PhD, DSc, Eng.
      - secretary: Anna Krukowska, MA;
3) The qualification team of the scientific discipline of civil engineering, geodesy and transport is composed of:
   a) Chairman: Colonel Krzysztof Pokonieczny, PhD, DSc, Eng.;
   b) Members:
      - prof. dr hab. inż. Adam Stolarski,
      - Agnieszka Zwirowicz-Rutkowska, PhD, DSc, Eng.,
      - Secretary: Sylwia Burdyńska, MSc;
4) The qualification team of the scientific discipline of materials engineering is composed of:
   a) Chairman: Prof. Tomasz Czujko, PhD, DSc, Eng.,;
   b) Members:
      - Wiktor Piecek, PhD, DSc, Eng.,
      - Col. Małgorzata Kopytko, PhD, DSc, Eng.,
      - Secretary: Lieutenant Colonel Krzysztof Karczewski, PhD;
5) Qualification Team No. 1 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Józef Pszczółkowski, PhD, DSc, Eng.;
   b) Members:
      - Prof. Jan Godzimirski, PhD, DSc, Eng.,
      - Danuta Miedzińska, PhD, DSc, Eng.,
      - Secretary: Janusz Kluczyński, PhD, Eng.;
6) Qualification Team No. 2 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Marek Rośkowicz, PhD, DSc, Eng.;
   b) Members:
      - Andrzej Typiak, PhD, DSc, Eng.,
      - Jacek Janiszewski, PhD, DSc, Eng.,
      - secretary: Anna Kutyła, MA;
7) The qualification team of the scientific discipline of chemical sciences is composed of:
   a) chairman: Prof. Marzena Tykarska;
   b) Members:
      - Michał Czerwiński, PhD, DSc, Eng.,
      - Wojciech Kiciński, PhD, DSc, Eng.,
      - Secretary: Jakub Nawała, PhD, Eng.;

8) The qualification team of the scientific discipline of safety science is composed of:
   a) chairman: Colonel Szymon Mitkow, PhD, DSc, Eng.;
   b) Members:
      - prof. Bogusław Jagusiak, PhD, DSc, Eng.,
      - prof. Tadeusz Szczurek, PhD, DSc, Eng.,
      - Marcin Górnikiewicz, PhD, DSc, Eng.;
      - secretary: Paweł Kawalerski, PhD.

§ 2

1. Persons participating in the work of the recruitment committee and qualification teams referred to in § 1 are entitled to a one-off remuneration, provided that:

1. professional soldiers - at the request of the Director of the Doctoral School on the terms set out in military regulations;

2. other WAT employees - at the request of the Director of the Doctoral School, in accordance with § 14 section 5 and § 34 of the Regulations on the remuneration of WAT employees, constituting an annex to the Ordinance of the Rector of WAT No. 33/WAT/2020 of 31 March 2020 on the introduction of the "Regulations on the remuneration of employees of the Jarosław Dąbrowski Military University of Technology"

3. The remuneration referred to in paragraph 1 shall be paid after the work of the recruitment committee and qualification teams has been completed.

§ 3

The Recruitment Committee and qualification teams, in the compositions specified in § 1, operate from 20 March 2023 to 15 March 2024.

§ 4

The decision enters into force on the day it is signed, with effect from 20 March 2023.

Rector

Brig. Gen. Prof. Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology
No. 98/RKR/2024 of 26.03.2024

on the appointment of the Recruitment Committee and Qualification Teams to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2024/2025

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 2 section 1 of the Annex to the Resolution No. 11/WAT/2024 of the Senate of the Military University of Technology of 29 February 2024 on the determination of the rules of recruitment to the Doctoral School of the Military University of Technology academic year 2024/2025, it is decided as follows:

§ 1

The following are appointed to conduct the recruitment procedure for the Jarosław Dąbrowski Doctoral School of the Military University of Technology for the academic year 2024/2025:

1. The Recruitment Committee composed of:
   1) chairman:
      - Piotr Zalewski, PhD, Eng.– Director of the Doctoral School;
   2) Members:
      - Prof. Waldemar Żendzian - scientific discipline of automation, electronics, electrical engineering and space technologies,
      - Janusz Furtak, PhD, DSc, Eng., - scientific discipline of technical informatics and telecommunications,
      - Albina Mościcka, PhD, DSc, Eng., - scientific discipline of civil engineering, geodesy and transport,
      - Wojciech Stępniowski, PhD, DSc, - Materials Engineering,
      - Stanisław Kachel, PhD, DSc, Eng., - scientific discipline of mechanical engineering,
      - Anna Spadło, PhD, DSc, Eng., - scientific discipline of chemical sciences,
      - Colonel Konrad Stańczyk - scientific discipline of security science,
      - Dariusz Podbielski, PhD, Eng. - Deputy Director of the Doctoral School;
   3) Secretary: Elżbieta Rąpała, MA - Head of the Dean's Office of the Doctoral School.
2. Qualification teams of scientific disciplines:

1) The qualification team of the scientific discipline of automation, electronics, electrical engineering and space technologies is composed of:
   a) chairman: Prof. Mateusz Pasternak, PhD, DSc, Eng.,
   b) Members:
      - prof. Andrzej Zając, PhD, DSc, Eng.,
      - Col. Jacek Wojtas, PhD, DSc, Eng.,
      - Secretary: Col. Jacek Wojtas, PhD, DSc, Eng.;
2) The qualification team of the scientific discipline of technical informatics and telecommunications is composed of:
   a) Chairman: Col. Jan Kelner, PhD, DSc, Eng.;
   b) Members:
      - Maciej Kiedrowicz, PhD, DSc, Eng.,
      - Janusz Dudczyk, PhD, DSc, Eng.,
      - secretary: Anna Krukowska, MA;
3) The qualification team of the scientific discipline of civil engineering, geodesy and transport is composed of:
   a) Chairman: Colonel Krzysztof Pokonieczny, PhD, DSc, Eng.;
   b) Members:
      - prof. Adam Stolarski, PhD, DSc, Eng.,
      - Agnieszka Zwirowicz-Rutkowska, PhD, DSc, Eng.,
      - Secretary: Sylwia Burdyńska, MSc;
4) The qualification team of the scientific discipline of materials engineering is composed of:
   a) Chairman: prof. Tomasz Czujko, PhD, DSc, Eng.;
   b) Members:
      - Wiktor Piecek, PhD, DSc, Eng.,
      - Col. Małgorzata Kopytko, PhD, DSc, Eng.,
      - Secretary: Col. Krzysztof Karczewski, PhD;
5) Qualification Team No. 1 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Józef Pszczółkowski, PhD, DSc, Eng.;
   b) Members:
      - prof. Jan Godzimirski, PhD, DSc, Eng.,
      - Danuta Miedzińska, PhD, DSc, Eng.,
      - Secretary: Janusz Kluczyński, PhD, Eng.;
6) Qualification Team No. 2 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Marek Rośkowicz, PhD, DSc, Eng.;
   b) Members:
      - Andrzej Typiak, PhD, DSc, Eng.,
      - Jacek Janiszewski, PhD, DSc, Eng.,
      - secretary: Anna Kutyła, MA;
7) The qualification team of the scientific discipline of chemical sciences is composed of:
   a) chairman: prof. Marzena Tykarska, PhD, DSc, Eng.,;
   b) Members:
      - prof. Waldemar Trzciński, PhD, DSc, Eng.,
      - Jakub Herman, PhD, DSc, Eng.,
      - Secretary: Daniel Dziedzic, PhD
8) The qualification team of the scientific discipline of safety science is composed of:

a) Chairman: Col. prof. Szymon Mitkow, PhD, DSc, Eng.,;
b) Members:
   - prof. Bogusław Jagusiak, PhD, DSc, Eng.,
   - prof. Tadeusz Szczurek, PhD, DSc, Eng.,
   - Marcin Górnikiewicz, PhD, DSc, Eng.;
   - secretary: Paweł Kawalerski, PhD.

§ 2

1. Persons participating in the work of the recruitment committee and qualification teams referred to in § 1 are entitled to a one-off remuneration, provided that:

1. professional soldiers - at the request of the Director of the Doctoral School on the terms set out in military regulations;

2. other WAT employees - at the request of the Director of the Doctoral School, in accordance with § 14 section 5 and § 34 of the Regulations on the remuneration of WAT employees, constituting an annex to the Ordinance of the Rector of WAT No. 45/WAT/2023 of 30 June 2023 on the introduction of the "Regulations on the remuneration of employees of the Military University of Technology"

3. The remuneration referred to in paragraph 1 shall be paid after the work of the recruitment committee and qualification teams has been completed.

§ 3

The Recruitment Committee and qualification teams, in the compositions specified in § 1, operate from 1 April 2024 to 31 March 2025.

§ 4

The decision enters into force on the day of signing.

Rector

Brig. Gen. Prof. Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology
No. 120/RKR/2025 of 27 March 2025

on the appointment of the Recruitment Committee and Qualification Teams to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2025/2026

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 2 section 1 of the Annex to the Resolution No. 8/WAT/2025 of the Senate of the Military University of Technology of 27 February 2025 on the determination of the rules of recruitment to the Doctoral School of the Military University of Technology for the academic year 2025/2026, it is decided as follows:

§ 1

The following are appointed to conduct the recruitment procedure for the Doctoral School of the Military University of Technology for the academic year 2025/2026:

1. The Recruitment Committee composed of:
   1) chairman:
      - Piotr Zalewski, PhD, Eng., Prof. WAT – Director of the Doctoral School;
   2) Members:
      - Prof. Waldemar Żendzian - scientific discipline of automation, electronics, electrical engineering and space technologies,
      - Colonel Jan Kelner, PhD, DSc, Eng., Prof. WAT - scientific discipline of technical informatics and telecommunications,
      - Albina Mościcka, PhD, DSc, Eng., Prof. WAT - scientific discipline of civil engineering, geodesy and transport,
      - Wojciech Stępniowski, PhD, DSc, Prof. WAT - Materials Engineering,
      - Stanisław Kachel, PhD, DSc, Eng., Prof. WAT - scientific discipline of mechanical engineering,
      - Anna Spadło, PhD, DSc, Eng., Prof. WAT - scientific discipline of chemical sciences,
      - Bogdan Ćwik, PhD, DSc, Eng., Prof. WAT - scientific discipline of safety science,
      - Dariusz Podbielski, PhD, Eng. - Deputy Director of the Doctoral School;
   3) Secretary: Elżbieta Rąpała, MA - Head of the Dean's Office of the Doctoral School.

2. Qualification teams of scientific disciplines:

1) The qualification team of the scientific discipline of automation, electronics, electrical engineering and space technologies is composed of:
   a) chairman: Prof. Mateusz Pasternak, PhD, DSc, Eng.,
   b) Members:
   - Col. prof. Norbert Pałka, PhD, DSc, Eng.,
   - Col. Jacek Wojtanowski, PhD, DSc, Eng.;
2) The qualification team of the scientific discipline of technical informatics and telecommunications is composed of:
   a) Chairman: Janusz Furtak, PhD, DSc, Eng.;
   b) Members:
   - Janusz Dudczyk, PhD, DSc, Eng.,
   - Piotr Kosiuczenko, PhD, DSc, Eng.,
   - secretary: Anna Krukowska, MA;
3) The qualification team of the scientific discipline of civil engineering, geodesy and transport is composed of:
   a) Chairman: Colonel Krzysztof Pokonieczny, PhD, DSc, Eng.;
   b) Members:
   - prof. Adam Stolarski, PhD, DSc, Eng.,
   - Agnieszka Zwirowicz-Rutkowska, PhD, DSc, Eng.,
   - Secretary: Sylwia Burdyńska, MSc;
4) The qualification team of the scientific discipline of materials engineering is composed of:
   a) Chairman: prof. Tomasz Czujko, PhD, DSc, Eng.;
   b) Members:
   - Col. prof. Małgorzata Kopytko, PhD, DSc, Eng.,
   - Wiktor Piecek, PhD, DSc, Eng.,
   - Secretary: Lieutenant Colonel Krzysztof Karczewski, PhD;
5) Qualification Team No. 1 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Józef Pszczółkowski, PhD, DSc, Eng.;
   b) Members:
   - Danuta Miedzińska, PhD, DSc, Eng.,
   - Tomasz Majewski, PhD, DSc, Eng.,
   - secretary: Adam Woźniak, PhD, Eng.;
6) Qualification Team No. 2 of the scientific discipline of mechanical engineering composed of:
   a) Chairman: Marek Rośkowicz, PhD, DSc, Eng.;
   b) Members:
   - Typiak, PhD, DSc, Eng.,
   - Jacek Janiszewski, PhD, DSc, Eng.,
   - secretary: Anna Kutyła, MA;
7) The qualification team of the scientific discipline of chemical sciences is composed of:
   a) chairman: prof. Marzena Tykarska. PhD, DSc, Eng.;
   b) Members:
   - Magdalena Urbańska, PhD, DSc, Eng.,
   - prof. Sławomir Neffe, PhD, DSc, Eng.,
   - Secretary: Sławomir Dyjak, PhD;

8) The qualification team of the scientific discipline of safety science is composed of:
   a) Chairman: Col. Prof. Szymon Mitkow, PhD, DSc, Eng.;
   b) Members:
- Aleksandra Skrabacz, PhD, DSc, Eng.,
- Sławomir Byłeń, PhD, DSc, Eng.,
- Jerzy Zalewski, PhD, DSc, Eng.;
- secretary: Anna Dybicz, MA.

§ 2

1. Persons participating in the work of the recruitment committee and qualification teams referred to in § 1 are entitled to a one-off remuneration, provided that:

1. professional soldiers - at the request of the Director of the Doctoral School on the terms set out in military regulations;

2. other WAT employees - at the request of the Director of the Doctoral School, in accordance with § 14 section 5 and § 34 of the Regulations on the remuneration of WAT employees, constituting an annex to the Ordinance of the Rector of WAT No. 17/RKR/2024 of 26 April 2024 on the introduction of the "Regulations on the remuneration of employees of the Military University of Technology"

3. The remuneration referred to in paragraph 1 shall be paid after the work of the recruitment committee and qualification teams has been completed.

§ 3

The Recruitment Committee and qualification teams, in the compositions specified in § 1, operate from 1 April 2025 to 31 March 2026.

§ 4

The decision enters into force on the day of signing.

Rector

/--/ Brig. Gen. Prof. Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 35/WAT/2019 of 30 May 2019

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (Journal of Laws, item 1668, as amended), in connection with the Article 291 of the Act of 3 July 2018. The provisions introducing the Act – Law on Higher Education and Science (Journal of Laws, item 1669, as amended) are hereby adopted as follows:

§ 1

The "Rules of Recruitment to the Doctoral School of the Military University of Technology for the academic year 2019/2020" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

(--) Big. Gen. Prof. Tadeusz SZCZUREK

Attachment to Resolution No. 35/WAT/2019 of the WAT Senate
of 30 May 2019

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2019/2020

§ 1

1. The Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2019/2020, in the following scientific disciplines:
    1) automation, electronics and electrical engineering;
    2) technical informatics and telecommunications;
    3) civil engineering and transportation;
    4) materials engineering;
    5) mechanical engineering;
    6) safety sciences;
    7) chemical sciences.

2. A person who holds a master's degree, a master's degree in engineering or an equivalent degree or is a beneficiary of the "Diamond Grant" program may be admitted to the Doctoral School.

3. In exceptional cases, justified by the highest quality of scientific achievements, a person who is a graduate of first-cycle studies or a student who has completed the third year of long-cycle master's studies may be admitted to the Doctoral School.

4. The rules and procedure for sending professional soldiers to the Doctoral School
in the official mode are regulated by the provisions *of the Act of 11 September 2003.*
on the military service of professional soldiers (t.j.Dz. U. of 2019, item 330).

5. Candidates with disabilities are subject to the same recruitment procedure as other candidates applying for admission to the Doctoral School.

6. The limit of places for the Doctoral School is set by the Rector at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".

§ 2

1. The recruitment procedure is conducted by the Doctoral School Admissions Committee appointed by the Rector, hereinafter referred to as the "Admission Committee". The chairman of the recruitment committee is the director.

2. The admission procedure to the Doctoral School consists of the following stages:
   1) the submission by the candidates of the documents referred to in paragraph 5;
   2) verification of documents;
   3) the qualification procedure – awarding ranking points by the recruitment committee;
   4) entry on the list of doctoral students or issuance of an administrative decision
      on refusal of admission to the Doctoral School.

3. A candidate for the Doctoral School submits to the admissions committee the documents
   referred to in paragraph 5 between **1 July 2019 and 19 August 2019:**
   1) in person or by another duly authorised person;
   2) by mail.

4. A candidate may apply for admission in only one scientific discipline conducted at the Doctoral School.

5. The candidate submits the following documents to the Dean's Office of the Doctoral School:
   1) application for admission together with a personal questionnaire, according to the template contained in Appendix No. 3;
   2) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of master's, master's degree in engineering or equivalent - does not apply to candidates referred to in § 1 section 3;
   3) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies - applies to candidates referred to in § 1 section 3;
   4) the original or a copy certified by the Dean's Office of the Doctoral School of the Diploma Supplement or other document confirming the course of studies;
   5) the original or a copy certified by the Dean's Office of the Doctoral School of the document confirming obtaining the "Diamond Grant" - applies only to the candidate, beneficiary of the "Diamond Grant" program);
   6) two current and signed photographs in the format provided for an identity document;
   7) the original or a copy certified by the Dean's Office of the Doctoral School of documents confirming scientific achievements, professional experience coinciding with the selected scientific discipline and predispositions for research work, including publications and activity in the scientific movement, if they have been mentioned in the questionnaire;

8) the original or a copy of language certificates certified by the Dean's Office of the Doctoral School;
9) curriculum vitae (CV);
10) an information clause resulting from the Act of 10 May 2018 on the protection of personal data (Journal of Laws of 2018, item 1000) and Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (GDPR) – according to the template contained in Annex 4;
11) in the case of possession of a certificate of disability or a certificate on the degree of disability or a certificate referred to in Article 5 and Article 62 of the Act of 27 August 1997. on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2018, item 511) – a copy of this decision.

6. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act of 20 July 2018 – Law on Higher Education and Science apply to the recognition of a diploma as entitling to undertake education at a doctoral school
.

7. In the event of submitting incomplete documents in the recruitment procedure, the recruitment committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate is not admitted to the qualification procedure.

8. An application referred to in paragraph 5(1) submitted or submitted after the deadline specified in paragraph 3 shall be returned without examination.

§ 3

1. The recruitment procedure is of a competitive nature.

2. Graduates of fields of study providing second-cycle qualifications, hereinafter referred to as "master's studies", may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1, subject to § 1 section 2 and section 3. A detailed list of fields of study is contained in Appendix No. 1.

3. In the case of a person holding a diploma of completion of a Master's degree programme other than that listed in Appendix 1 or studies completed outside Polish, the Admission Committee decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline. The admissions committee may ask the candidate to submit additional documents.

4. In the recruitment procedure, subject to § 1 sections 2 and 3, the Admission Committee awards ranking points to candidates, taking into account:
   1) the result of the candidate's completion of the master's degree;
   2) qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline;
   3) scientific achievements of the candidate.

5. The maximum number of points that can be awarded by the admissions committee is 100.

6. Detailed rules for calculating the candidate's ranking points are specified in Appendix No. 2.

7. In the event that a beneficiary of the "Diamond Grant" program applies for admission, the admissions committee decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline and awards the candidate with the maximum number of ranking points.

8. In the case of candidates referred to in § 1 section 3, the Admission Committee decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline and awards the candidate with the maximum number of ranking points.

§ 4

1. The results of the recruitment procedure are public and will be announced by **6 September 2019.**

2. The recruitment committee draws up a protocol on the recruitment process, to which a document called the ranking list of candidates is attached. The order in which candidates are placed on the ranking list is determined by the number of ranking points (from the highest to the lowest number of points). The ranking list includes:
   1) the names and surnames of the candidates and the codes assigned to them;
   2) the number of ranking points awarded for each element of the procedure assessed, in accordance with Annex 2;
   3) the final result of the candidates – the sum of the ranking points;
   4) indicating whether the candidate has been qualified to be entered on the list of doctoral students of the Doctoral School.

   The ranking list with codes instead of names and surnames of candidates is subject to publicity.

3. The protocol is signed by the members of the recruitment committee, and the ranking list is signed by the chairperson of the recruitment committee.

4. The protocol is signed by the members of the recruitment committee who took part in the recruitment procedure. Any deletions and changes made to the

ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the committee.

5. The admission of a candidate to the Doctoral School in the academic year 2019/2020, within the limit of places for a scientific discipline, is determined by the order of places on the ranking list ranked according to the decreasing number of points.

6. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
    1) achievements referred to in § 3 section 4 point 3;
    2) the result referred to in § 3 section 4 point 1;
    3) qualifications and competences referred to in § 3 section 4 point 2.

7. In the absence of a decision on the basis of the conditions referred to in paragraph 5, the decision on admission to the Doctoral School is made by the admissions committee.

§ 5

1. Admission to the Doctoral School takes place by entering the list of doctoral students.

2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

§ 6

1. The rules set out in the resolution apply to Polish citizens.

2. Persons who are not Polish citizens may undertake and complete education at the Doctoral School on the terms set out in the Act of 20 July 2018 – Law on Higher Education and Science.

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

List of fields of study whose graduates may apply for admission to the Doctoral School

Scientific discipline conducted at the Doctoral School	Completed Master's degree
Automation, Electronics and Electrical Engineering	- Automation and robotics - Electronics - Electronics & Telecommunications - electrical engineering - Energy - physics - Technical physics - Photonics - Materials Engineering - Mechatronics - computer science
Technical Informatics and Telecommunications	- Automation and robotics - Electronics & Telecommunications - computer science - Computer Science and Econometrics
Civil Engineer & Transportation	- Construction - Geodesy and Cartography - geophysics - geography - geology - physics - computer science - navigation
Materials Engineering	- chemistry - physics - Technical physics - chemical and process engineering - Materials Engineering - Production Engineering - mechanics and mechanical engineering - metallurgy - Chemical Technology
Mechanical Engineering	- Materials Engineering - logistics - mechanics and mechanical engineering - Mechatronics - transport - Production Management and Engineering - Automation and robotics - Technical physics - Aerospace
Chemical Sciences	- chemistry - Chemical Technology - chemical and process engineering - biotechnology - Materials Engineering - biochemistry - environmental protection - Environmental Engineering - physics
Security Sciences	- National security - internal security - European Studies - Safety Engineering - logistics - political science - international relations - management - National defence - State security management

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

Detailed rules for calculating candidate ranking points

The Admission Committee awards the candidate's ranking points on the basis of:

Basis for calculating ranking points	Number of Ranking Points
1. Result of completion of the master's degree	0 ÷ 50
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 20
3. Scientific achievements	0 ÷ 30

1. On the basis of the assessment of the completion of the Master's degree, the Admission Committee awards ranking points according to the following rules:

Result of completion of the master's degree	Number of Ranking Points
5w	50
5	45
4+	40
4	30
3+	0
3	0

2. The assessment of the candidate's qualifications and competences is carried out by the recruitment committee and points are awarded according to the following rules:

Qualifications and competencies of the candidate	Number of Ranking Points
1) motivation to conduct research work	0 ÷ 10
2) documented research internships, individual studies	0 ÷ 5
3) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
4) Language certificate	0 ÷ 2

1) the candidate's motivation to conduct research work - up to 10 points is estimated on the basis of the information provided in the information questionnaire;
2) documented scientific internships, individual studies – up to 5 points on the basis of certificates;
3) certificates and certificates proving the acquisition of qualifications needed for scientific work – up to 3 points

on the basis of copies of certificates, certificates and attestations;

4) A certificate of foreign language proficiency – up to 2 points:
   a. lack of certificate or below B2 level – 0 points;
   b. at B2 level - 1 point;
   c. at a level above B2 – 2 points.

3. The candidate's scientific achievements are assessed by the recruitment committee and points are awarded according to the following rules:

Candidate's scientific achievements	Number of Ranking Points
1) Documented scientific publications	0 ÷ 30
2) documented awards and scholarships of the Ministry of Science and Higher Education, Rector's awards and scholarships, distinctions for the best diploma thesis, other awards and recognitions for research activities	0 ÷ 10
3) documented achievements in the Students' Scientific Club (KNS)	0 ÷ 5

Note: *the sum of points for the candidate's scientific achievements cannot exceed 30, priority is given to points for documented scientific publications.*

1) For documented scientific publications in a selected scientific discipline, the Admission Committee awards points according to the following rules:
   a. monograph in a scientific discipline – up to 15 points;
   b. a chapter in a multi-author monograph – up to 5 points;
   c. scientific publication in journals from the list of journals of the Ministry of Science and Higher Education – up to 10 points;
   d. scientific publication in journals outside the list of journals of the Ministry of Science and Higher Education – up to 5 points;
   e. participation in a scientific conference with a presentation of a paper – up to 3 points;
   f. paper in conference materials - up to 2 points

   The sum of points cannot exceed 30.

2) for documented awards and scholarships of the Ministry of Science and Higher Education, Rector's awards and scholarships, other awards and recognitions for research activities, the Admission Committee awards points according to the following rules:
   a. obtaining an award and a scholarship from the Ministry of Science and Higher Education – up to 5 points;
   b. obtaining an award and a scholarship from the Rector of a higher education institution – up to 3 points;
   c. distinction for the best diploma thesis – up to 2 points

   The sum of points cannot exceed 10.

3) for documented achievements in the KNS, the recruitment committee awards points according to the following rules:
   a. distinction in the competition for the best student work within the activities of the KNS - up to 5 points;
   b. distinction for speaking at the KNS seminar - up to 2 points

   The sum of points cannot exceed 5.

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

/TEMPLATE OF THE APPLICATION FOR ADMISSION TO THE DOCTORAL SCHOOL TOGETHER WITH THE INFORMATION QUESTIONNAIRE/

..... *....., ...*
Candidate's name *locality* *data*

RECTOR
Military University of Technology

REQUEST

I would like to ask you to accept me to the Doctoral School of the Military University of Technology in the scientific discipline of .....
for the academic year 2019/2020.

Attached is an information questionnaire with documents confirming qualifications, competences and scientific achievements.

....
city, date *Candidate's signature*

Attachments:

1. Information questionnaire.
2. Diploma confirming obtaining a professional title.
3. Diploma Supplement.
4. A document confirming obtaining the "Diamond Grant".
5. 2 Photography.
6. Documents confirming scientific achievements, professional experience.
7. Language certificates.
8. Curriculum vitae (CV).
9. Information clause.
10. Disability certificates.

INFORMATION QUESTIONNAIRE

1. Identification data of the applicant:

surname..... Name 1 ..... 2 .....

family name (for married women) .....

father/mother's name.....

Date of Birth *(dd-MM-yyyy):* ..... - ..... - ..... PESEL ....

Place of birth..... country.....

citizenship..... ID card series and number..... ....

2. Permanent residence registration address:

locality:..... hive.:.....

Thought No. : ..... Room No. : .....

Postal code: ..... - ..... mail:.....

voivodeship:.....

country:.....

....

3. Correspondence address: *(if different from the address of residence)*

locality:..... hive.:.....

Thought No. : ..... Room No. : .....

Postal code: ..... - ..... mail:.....

country:.....

.....

4. Contact:

a) landline.....

b) mobile phone.....

c) Email.....

5. Master's degree diploma:

a) University Name:

.....

b) Completed field of study: .....

c) Result of completing master's studies: .....

d) No., date and place of issue of the diploma: .....

e) Master's thesis title:.....

.....

.....

f) title, academic degree, name and surname of the supervisor of the master's thesis (supervisor)

.....

6. Do you have a doctoral degree? If so, please indicate when and where it was obtained and in which scientific discipline

.....

7. Have you had or have you initiated a doctoral dissertation? If so, please indicate where and in which scientific discipline

.....

8. Professional career in the last three years:

Period	Name of the workplace	Locality	Position

9. Please state the reasons for your decision (motivation) to apply for the Doctoral School and conduct research in the selected discipline

……

……

……

……

10. Please indicate your preferred subject matter of the research work (individual research plan) within the selected scientific discipline

……

……

……

11. Please provide the title, academic degree, name and place of work of the person who has initially agreed to act as a supervisor:

……

……

12th Please list the scientific internships and individual studies referred to in Appendix 2 section 2 item 2 (documents certifying § 2 section 5 point 7)

……

……

……

13. Please list the certificates and certificates proving the acquisition of qualifications needed for scientific work in accordance with Appendix No. 2 section 2 item 3 (certifying documents in accordance with § 2 section 5 point 7)

……

……

……

14. Please list the certificates of knowledge of a foreign language in accordance
with Appendix No. 2 section 2 item 4 (certifying documents in accordance with § 2 section 5 point 8)

……

……

……

15. Please list scientific publications in the selected scientific discipline in accordance with Appendix No. 2 section 3 item 1 (certifying documents in accordance with § 2 section 5 point 7)

a) Monograph in a scientific discipline

……

……

……

b) chapter in a multi-author monograph

……

……

……

c) scientific publication in journals from the list of journals of the Ministry of Science and Higher Education

……

……

……

d) scientific publication in journals outside the list of journals of the Ministry of Science and Higher Education

……

……

……

16. Please list conferences and scientific papers in accordance with Appendix 2 section 3 item 1 (certifying documents in accordance with § 2 section 5 point 7)

a) participation in a scientific conference with presentation of a paper

……

……

……

b) paper in conference materials

……

……

……

17. Please list the awards and scholarships received in accordance with Appendix No. 2 section 3 item 2 (certifying documents in accordance with § 2 section 5 point 7)

……

……

……

18. Please list the achievements in the Students' Scientific Club in accordance
with Appendix No. 2 section 3 item 3 (certifying documents in accordance with § 2 section 5 point 7).

……

……

……

19. Please provide the name of a person who can give an opinion on your predispositions for scientific work

a) .....

title, degree, name, surname, place of work and email address

....

city, date signature of the candidate

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2019/2020

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of a provision of law, i.e. on the basis of Article 6(1)(c) of the GDPR in conjunction with Article 200 of the Act of 20 July 2018. Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) and pursuant to Article 9(2)(b) of the GDPR in conjunction with Article 209(7) of the Act of 20 July 2018. The Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) - for the purposes of recruitment, and after admission to the Doctoral School, will be processed on the basis of the law, i.e. on the basis of Article 6(1)(c) of the GDPR in conjunction with Article 201 of the Act of 20 July 2018. Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended) and pursuant to Article 9(2)(b) of the GDPR in conjunction with Article 209 of the Act of 20 July 2018. Law on Higher Education and Science (Journal of Laws of 2018, item 1668, as amended).
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit for doctoral studies. As for providing data on disability – providing them is voluntary, however, failure to provide this information will make it impossible to receive a doctoral scholarship in an increased amount.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;

8. You have the right to access the content of your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....

city, date *legible signature of the candidate*

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 123/WAT/2020 of 27 February 2020

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85), in connection with the with § 21 section 1 point 27 of the Statute of the Military University of Technology constituting an annex to the resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019) The following is resolved:

§ 1

The "Rules of Recruitment to the Jarosław Dąbrowski Military University of Technology Doctoral School for the academic year 2020/2021" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

/--/ Brig. Gen. Prof. Tadeusz SZCZUREK

Attachment
to Resolution No. 123/WAT/2020 of the Senate of the Military University of Technology
of 27 February 2020

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2020/2021

§ 1

1. The Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2020/2021, in the following scientific disciplines:
   1) automation, electronics and electrical engineering;
   2) technical informatics and telecommunications;
   3) civil engineering and transportation;
   4) materials engineering;
   5) mechanical engineering;
   6) safety sciences;
   7) chemical sciences.
2. A person who holds a master's degree, a master's degree in engineering or an equivalent degree or is a beneficiary of the "Diamond Grant" program may be admitted to the Doctoral School.
3. In exceptional cases, justified by the highest quality of scientific achievements, a person who is a graduate of first-cycle studies or a student who has completed the third year of long-cycle master's studies may be admitted to the Doctoral School.
4. The rules and procedure for the referral of professional soldiers to the Doctoral School are regulated by the provisions *of the Act of 11 September 2003. on military service of professional soldiers* (i.e. Journal of Laws of 2019, item 330, as amended).
5. Candidates with disabilities are subject to the same recruitment procedure as other candidates applying for admission to the Doctoral School.
6. The limit of places for the Doctoral School is set by the Rector at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".

§ 2

1. The recruitment procedure is conducted by the Doctoral School Admissions Committee appointed by the Rector, hereinafter referred to as the "Admission Committee".
2. The recruitment committee consists of:
   1) chairman – director;
   2) at least three academic teachers holding the degree of habilitated doctor or the academic title of professor representing each of the scientific disciplines referred to in § 1 section 1;
   3) other persons indicated by the headteacher.
3. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
4. In justified cases, at the request of the Chairperson, the Rector may appoint new or dismiss already appointed members of the Recruitment Committee.

5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The Recruitment Committee is appointed by the Rector for the period from 16 March 2020 to 31 December 2020.
7. The Recruitment Committee appoints from among the members of the Committee qualification teams for scientific disciplines, hereinafter referred to as "teams", to conduct the qualification procedure referred to in § 4 section 1 points 4 and 5. The recruitment committee appoints the chairman of the team.
8. In special cases, the composition of the teams may be modified by the committee. The chair of the panel convenes the meetings of the team and chairs its deliberations.
9. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
10. The meetings of the recruitment committee are recorded. The minutes are signed by the chairman and other members of the committee participating in the meeting.
11. The Recruitment Committee makes decisions in the form of resolutions. Resolutions are adopted by a simple majority of votes, in the presence of at least half of the members of the committee. In the event of an equal number of votes, the chairman's vote is decisive.
12. In the absence of the chairperson, the meeting of the committee shall be convened
    and chaired by a member of the committee authorised by the chairperson.

§ 3

1. A member of the recruitment committee is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the admissions committee shall inform the chairperson of the admissions committee of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School. The Selection Committee may decide to exclude a member of the Board from the evaluation procedure of a given candidate if the participation of that member could raise reasonable doubts.
3. A member of the Recruitment Committee is subject to exclusion from the assessment of a candidate
   , in particular if:
   1) plans to take on the duties of a supervisor or assistant supervisor of the candidate;
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) has participated in disciplinary proceedings in which a candidate for a doctoral school or a candidate for its supervisor has been accused;

7) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.

4. The exclusion of a member of the recruitment committee from the assessment of a given candidate is recorded in the minutes of the committee meeting.

§ 4

1. The admission procedure to the Doctoral School consists of the following stages:
   1) registering the candidate in the Internet Candidate Registration System (IRK);
   2) the submission by the candidate of the documents referred to in paragraph 4;
   3) verification of the completeness of the submitted documents;
   4) qualification procedure:
      a. analysis of the compliance of the Master's degree programme completed by the candidate with the list of fields of study included in Appendix No. 1 or, in the case of candidates referred to in paragraph 2, an assessment of the relationship between the candidate's scientific achievements and one of the scientific disciplines indicated in § 1 section 1;
      b. awarding ranking points by the Recruitment Committee for:
         – the result of completing master's studies,
         – qualifications and competences for education at the Doctoral School,
         – scientific achievements,
      c. awarding ranking points by the admissions committee for an interview;
   5) establishing a ranking list of candidates in individual scientific disciplines;
   6) entering into the list of doctoral students or issuing an administrative decision
      on refusal of admission to the Doctoral School.
2. In the case of beneficiaries of the "Diamond Grant" programme and candidates referred to in § 1 section 3, the recruitment procedure does not include the activities specified in paragraph 1 point 4 letter b.
3. A candidate for the Doctoral School registers in the IRK system **from 17 August 2020 to 30 August 2020.**
4. After registering in the IRK system, the candidate submits to the Dean's Office of the Doctoral School by **1 September 2020.** the following documents**:**
   1) an application for admission to the Doctoral School generated from the IRK system;
   2) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of master's, master's degree in engineering or equivalent - does not apply to candidates
      referred to in § 1 section 3;
   3) the original or a copy certified by the Dean's Office of the Doctoral School of the diploma confirming the acquisition of the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies - applies to candidates referred to in § 1 section 3;

4) the original or a copy certified by the Dean's Office of the Doctoral School of the Diploma Supplement or other document confirming the course of studies;
5) the original or a copy certified by the Dean's Office of the Doctoral School confirming obtaining the "Diamond Grant" - applies only to the candidate, beneficiary of the "Diamond Grant" program;
6) professional questionnaire (Appendix No. 3) together with originals or copies certified by the Dean's Office of the Doctoral School confirming professional experience, qualifications and competences for education at the Doctoral School;
7) a scientific questionnaire (Appendix No. 4) with originals or copies of documents confirming scientific achievements certified by the Dean's Office of the Doctoral School;
8) curriculum vitae (CV);
9) information clause concerning the processing of personal data – according to the template contained in Appendix No. 5.

5. The application with the documents can be submitted by the candidate
   1) in person or by another duly authorised person;
   2) by mail.
6. A candidate may submit an application and apply for admission to the Doctoral School only in one of the scientific disciplines referred to in § 1 section 1.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act of 20 July 2018 – Law on Higher Education and Science apply to the recognition of a diploma as entitling to undertake education at a doctoral school .
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the requirements referred to in § 1 section 2 or § 1 section 3, the recruitment committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.
9. An application referred to in paragraph 4(1) submitted or submitted after the deadline specified in paragraph 4 shall be left unexamined.

§ 5

1. The admission fee for registration to the Doctoral School is PLN 100.
2. The candidate pays the recruitment fee no later than on the date of completion of registration in the IRK system, i.e. 30 August 2020.
3. The candidate makes a payment to an individual bank account generated for each candidate by the IRK system.
4. In a particularly justified case, the candidate may, by 30 August 2020, submit an application to the Rector for exemption from the recruitment fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
5. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.

6. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 4 or the expiry of the deadline referred to in paragraph 5, the candidate shall not be subject to the qualification procedure.
7. The candidate is entitled – at his/her request – to a refund of the recruitment fee
   in the event of:
   1) resignation from participation in the qualification procedure before its commencement, i.e. before 7 September 2020;
   2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

§ 6

1. The recruitment procedure is of a competitive nature.
2. Candidates who are graduates of fields of study providing second-cycle qualifications, hereinafter referred to as "master's studies", may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1, subject to paragraph 12, a detailed list of fields of study is contained in Appendix No. 1.
3. In the case of a person holding a diploma of completion of a master's degree programme other than that listed in Appendix 1 or studies completed outside Polish, the team competent for the scientific discipline selected by the candidate decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline. The team may ask the candidate to present additional documents at the interview.
4. In the qualification procedure within individual scientific disciplines, the teams award ranking points to candidates on the terms set out in Appendix No. 2 and submit them to the recruitment committee for approval.
5. The number of ranking points of the candidate for each criterion is the arithmetic average of the points awarded by each team member, rounded up to the second decimal place, and cannot be greater than the maximum value specified for the criterion.
6. The interview with the candidates is conducted and the ranking points are awarded by a team of at least three people.
7. Information about the individual date and place of the interview is provided to candidates via the IRK system, by e-mail and on the website of the Doctoral School by 5 September 2020.
8. The maximum number of ranking points that can be awarded by the admissions committee is 100.
9. **A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only if they meet the formal requirements and obtain a total of at least 50 ranking points, including at least 20 points from the interview.**
10. Failure to meet the conditions referred to in paragraph 9 makes it impossible to enter the candidate on the list of doctoral students even if the limit of places for the scientific discipline is not used.
11. Detailed rules for calculating the candidate's ranking points are specified in Appendix No. 2.

12. In the case of beneficiaries of the "Diamond Grant" programme and candidates referred to in § 1 section 3, the relevant team:
    1) decides whether the candidate's scientific achievements are related to the scientific discipline referred to in § 1 section 1,
    2) if the condition specified in point 1 is met, the candidate is awarded 60 points,
    3) conducts an interview in accordance with paragraphs 4-8.
13. Before accepting the teams' proposals to award ranking points to candidates, the Recruitment Committee may commission the team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.

§ 7

1. The results of the recruitment procedure are public and will be announced by **16 September 2020.**
2. The recruitment committee draws up a protocol on the recruitment process, to which a document called the ranking list of candidates is attached.
3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the conditions referred to in § 6 section 9.
4. Candidates who do not meet the conditions referred to in § 6 section 9 are placed on the ranking list in a separate group below the candidates who meet these conditions.
5. The ranking list includes:
    1) names and surnames of candidates;
    2) the number of ranking points awarded for each criterion evaluated, in accordance with Appendix No. 2;
    3) the final result of the candidates – the sum of the ranking points;
    4) indicating whether the candidate has been qualified to be entered on the list of doctoral students of the Doctoral School.
6. The protocol is signed by the members of the recruitment committee, and the ranking list is signed by the chairperson of the recruitment committee.
7. The protocol is signed by the members of the recruitment committee who took part in the recruitment procedure. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the committee.
8. The admission of a candidate to the Doctoral School for the academic year 2020/2021, within the limit of places for a scientific discipline, is determined by the order of places on the ranking list ranked according to the decreasing number of points, provided that they meet the formal requirements and obtain a total of at least 50 ranking points, including at least 20 points from the interview.
9. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
    1) an interview referred to in § 4 section 1 point 4 letter c;
    2) scientific achievements referred to in § 4 section 1 point 4 letter b indent 3;
    3) the result of graduation referred to in § 4 section 1 point 4 letter b indent 1;
    4) qualifications and competences referred to in § 4 section 1 point 4 letter b, indent 2.

10. In the absence of a decision on the basis of the conditions referred to in paragraph 9, the decision on admission to the Doctoral School is made by the admissions committee.

§ 8

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

§ 9

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a separate competition procedure, outside the limits of places specified in § 1 section 6.
2. Only people who meet the conditions of the "Implementation Doctorate" program, in particular employees of companies cooperating with the Military University of Technology, can take part in the implementation recruitment.
3. The schedule for conducting the implementation recruitment, the template of the application submitted by the potential supervisor and the candidate's application, together with a list of documents that the candidate is obliged to submit at each stage of the implementation recruitment, is determined by the recruitment committee and made public on the website of the Doctoral School of the Military University of Technology by 20 March 2020.
4. Implementation recruitment is carried out by the recruitment committee in two stages:
    1) preliminary stage;
    2) final stage, subject to paragraph 7.
5. The initial stage includes:
    1) assessment of the draft proposal prepared by the potential promoter;
    2) assessment of the candidate's fulfilment of the formal requirements for participation in the programme on the basis of the documents referred to in paragraph 3;
    3) qualification procedure referred to in § 4 section 1 points 2-5.
6. After the completion of the initial stage, the candidate is entered on the ranking list of candidates for admission to the Doctoral School under the program and an application is submitted to the Minister of Science and Higher Education (MNiSW) to qualify WAT to participate in the "Implementation Doctorate" program, or in the event of a negative assessment of the draft proposal prepared by a potential supervisor or the candidate fails to meet the formal requirements or does not obtain it during the procedure qualification of the minimum number of points specified in § 6 section 9, the candidate receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2020/2021 under this programme.

7. The final stage is carried out only if the Ministry of Science and Higher Education provides information on the qualification of the WAT proposal for participation in the "Implementation Doctorate" programme, together with information on the number of doctoral students who can be admitted to the Doctoral School under this programme for the academic year 2020/2021 and the amount of financial resources broken down by academic years.
8. If the Ministry of Science and Higher Education provides information about the non-qualification of the WAT application for participation in the "Implementation Doctorate" programme, the Rector issues a decision to refuse admission of the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
9. The final stage applies only to candidates who have been entered on the ranking list for admission to the Doctoral School under the program at the initial stage and includes:
    a. registration of the candidate in the IRK system;
    b. payment by the candidate of the recruitment fee referred to in § 5 section 1;
    c. the candidate provides the documents referred to in paragraph 3;
    d. the recruitment committee conducts the qualification of candidates from the ranking list for admission to the Doctoral School, taking into account the limits of places referred to in paragraph 7 and the candidate's fulfilment of the requirements for participation in the programme.
10. The admissions committee may ask the candidate to submit additional documents confirming that they meet the requirements to participate in the program.
11. As a result of the final stage, the candidate is entered on the list of doctoral students of the Doctoral School for the academic year 2020/2021 as part of the "Implementation Doctorate" program, or receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2020/2021 under this program
12. The candidate's participation in the induction recruitment does not preclude his/her participation in the recruitment to the Doctoral School for the academic year 2020/2021.

§ 10

1. The rules set out in the resolution apply to Polish citizens.
2. Persons who are not Polish citizens may undertake and complete education at the Doctoral School on the terms set out in the Act of 20 July 2018 – Law on Higher Education and Science.

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

List of fields of study whose graduates may apply for admission to the Doctoral School

Scientific discipline conducted at the Doctoral School	Completed Master's degree
Automation, Electronics and Electrical Engineering	- Automation and robotics - electronics - Electronics & Telecommunications - electrical engineering - Energy - physics - Technical physics - Photonics - Materials Engineering - Mechatronics - computer science
Technical Informatics and Telecommunications	- Automation and robotics - Electronics & Telecommunications - electrical engineering - computer science - Computer Science and Econometrics
Civil Engineer & Transportation	- Construction - Geodesy and Cartography - geophysics - geography - geology - physics - computer science - navigation
Materials Engineering	- chemistry - physics - Technical physics - chemical and process engineering - Materials Engineering - Production Engineering - mechanics and mechanical engineering - metallurgy - Chemical Technology
Mechanical Engineering	- Materials Engineering - logistics - mechanics and mechanical engineering - Mechatronics - transport - Production Management and Engineering - Automation and robotics - Technical physics - Aerospace
Chemical Sciences	- chemistry - Chemical Technology - chemical and process engineering - biotechnology - Materials Engineering - biochemistry - environmental protection - Environmental Engineering - physics
Security Sciences	- National security - internal security - European Studies - Safety Engineering - logistics - political science - international relations - management - National defence - State security management

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

Detailed rules
calculating the candidate's ranking points

The team referred to in § 2 section 7 of the Recruitment Rules awards ranking points to the candidate on the basis of the following criteria:

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in point 5
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Interview	0 ÷ 40	0÷ 40

1. On the basis of the assessment of completion of the Master's degree programmes , the team referred to in § 2 section 7 of the Recruitment Rules awards ranking points according to the following rules:

Completion Score Master's Degree	Number of points Ranked
5w	20
5	15
4+	10
4	5
less than 4	0

2. The assessment of the candidate's qualifications and competences is carried out by the team referred to in § 2 section 7 of the Recruitment Rules and awards ranking points according to the following rules:

Qualifications and competencies of the candidate	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
3) language certificate above B2	2

3. The candidate's scientific achievements are assessed by the team referred to in § 2 section 7 of the Recruitment Rules and award ranking points according to the following rules:

Candidate's scientific achievements	Number of Ranking Points
1) Documented scientific publications	0 ÷ 30
2) documented awards or scholarships of the Ministry of Science and Higher Education, Rector's awards or scholarships, distinctions for the best diploma thesis, other awards or recognitions for research activities	0 ÷ 10
3) documented achievements in the Students' Scientific Club (KNS)	0 ÷ 5
4) documented participation in research projects	0 ÷ 15

Note: the *number of ranking points for the criterion of scientific achievement of the candidate is the sum of the points awarded for the four elements of this criterion; in the event that this sum is greater than 30 points, the candidate is awarded* ***30 points.***

1) for documented scientific publications in a selected scientific discipline according to the following rules – **max. 30 points:**
   a. monograph in a scientific discipline – up to 15 points;
   b. a chapter in a multi-author monograph – up to 5 points;
   c. scientific publication in journals from the list of journals of the Ministry of Science and Higher Education – up to 10 points;
   d. scientific publication in journals outside the list of journals of the Ministry of Science and Higher Education – up to 5 points;
   e. participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials – up to 5 points;

2) for documented awards and scholarships of the Ministry of Science and Higher Education, Rector's awards and scholarships, other awards and recognitions for research activities according to the following rules – **max. 10 points:**
   a. obtaining an award or scholarship from the Ministry of Science and Higher Education – up to 5 points;
   b. obtaining an award or scholarship from the rector of the university – up to 3 points;
   c. distinction for the best diploma thesis – up to 2 points

3) for documented achievements in the KNS, the recruitment committee awards points according to the following rules – **max. 5 points:**
   a. distinction in the competition for the best student work within the activities of the KNS - up to 3 points;

b. distinction for speaking at the KNS seminar - up to 2 points.

4) on the basis of the statements of the principals of research projects on the candidate's participation in these projects – **max. 15 points.**

4. The interview is conducted by the Team referred to in § 2 section 7 of the Recruitment Rules and awards ranking points according to the following rules:

Interview	Number of Ranking Points
1) motivation to conduct research work, including obtaining initial approval of a potential supervisor	0 ÷ 15
2) presentation of the candidate's own interests and scientific achievements	0 ÷ 10
3) ability to conduct a scientific discussion	0 ÷ 5
4) general knowledge of the scientific discipline	0 ÷ 10

5. In the case of beneficiaries of the "Diamond Grant" programme and candidates referred to in § 1 section 3 of the Recruitment Rules, for whom the team referred to in § 2 section 7 of the Recruitment Rules decided that the candidate's scientific achievements are related to the scientific discipline referred to in § 1 section 1 of the Recruitment Rules, 60 points are awarded.

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

PROFESSIONAL QUESTIONNAIRE

surname..... name.....

1. Master's degree

a) University Name:

.....

b) Completed field of study: .....

c) Result of completing master's studies: .....

d) No., date and place of issue of the diploma: .....

e) Master's thesis title:.....

.....

.....

f) title, academic degree, name and surname of the supervisor of the master's thesis (supervisor)

.....

2. Do you have a doctoral degree? If so, please let me know when and where it was obtained and in which scientific discipline.

.....

3. Have you had or have you initiated a doctoral dissertation? If so, please indicate where and in which scientific discipline:

.....

4. Professional career in the last three years:

Period	Name of the workplace	Locality	Position

5. Please list foreign trips (e.g. Erasmus), internships, individual studies - referred to in Appendix 2 point 2 item 1.

……

……

……

6. Please list the certificates and certificates proving the acquisition of qualifications needed for scientific work - referred to in Appendix No. 2 point 2 item 2.

……

……

……

7. Please list the certificate of foreign language proficiency above the B2 level, referred to in Appendix No. 2 point 2 item 3.

……

……

……

....

city, date signature of the candidate

<u>Attachments</u>

- documents certifying qualifications and professional achievements from points 2 and 5-7

1. ..... (original/copy)*
2. ..... (original/copy)*
3. ..... (original/copy)*
4. ..... (original/copy)*
5. ..... (original/copy)*

** delete unnecessary*

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

SCIENTIFIC QUESTIONNAIRE

surname..... name.....

1. Please list scientific publications in the selected scientific discipline in accordance with Appendix No. 2 point 3 item 1

a) Monograph in a scientific discipline

……

……

……

b) chapter in a multi-author monograph

……

……

……

c) scientific publication in journals from the list of scientific journals of the Ministry of Science and Higher Education

……

……

……

d) scientific publication in journals outside the list of scientific journals of the Ministry of Science and Higher Education

……

……

……

e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials

……

……

……

……

……

2. Please list the awards or scholarships received in accordance with Appendix No. 2 point 3 item 2

a) Award or scholarship of the Ministry of Science and Higher Education:

……

……

b) Obtaining an award or scholarship from the Rector of the University:

……

……

c) Distinction for the best diploma thesis:

……

……

3. Please list your achievements in the Students' Scientific Club (KNS) in accordance with Appendix No. 2 point 3 item 3

a) distinction in the competition for the best student work within the activities of the KNS

……

……

b) distinction for speaking at the KNS seminar

……

……

4. List the research projects in which you have participated in the last 5 years:

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title, degree, name and surname Manager Project	% of project participation

5. Please provide the name of a person who can give an opinion on your predispositions for scientific work

.....
title, degree, name, surname, place of work and email address

6. Please indicate your preferred research topic within the selected scientific discipline

……

……

……

7. Please provide the title, academic degree, name and place of work of the person who has initially agreed to act as a supervisor:

……

……

……

……

……

....
city, date signature of the candidate

<u>Attachments</u>

- documents confirming the achievements referred to in points 1-4

1. ..... (original/copy)*
2. ..... (original/copy)*
3. ..... (original/copy)*
4. ..... (original/copy)*
5. ..... (original/copy)*

** delete unnecessary*

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2020/2021

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018 on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit for the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Resolution
Senate of the Military University of Technology
Jarosław Dąbrowski

No. 9/WAT/2021 of 25 February 2021

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
Jarosław Dąbrowski for the academic year 2021/2022

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended), in connection with § 21(1)(27) of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019) The following is resolved:

§ 1

The "Rules of Recruitment to the Doctoral School of the Military University of Technology for the academic year 2021/2022" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

/--/ Col. Prof. Przemysław Wachulak

Attachment
to Resolution No. 9/WAT/2021 of the Senate of the Military University of Technology
of 25 February 2021

Rules of recruitment
to the Doctoral School of the Military University of Technology Jarosław Dąbrowski for the academic year 2021/2022

Section I
General

§ 1

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2021/2022, in the following scientific disciplines:
   1) automation, electronics and electrical engineering;
   2) technical informatics and telecommunications;
   3) civil engineering and transportation;
   4) materials engineering;
   5) mechanical engineering;
   6) safety sciences;
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School is carried out by means of a competition in accordance with these Rules of Recruitment to the Doctoral School of the Military University of Technology for the academic year 2021/2022, hereinafter referred to as the "Recruitment Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines, within the framework of which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as those applicable to Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for directing professional soldiers to the Doctoral School in the official mode are regulated by the provisions of the Act of 11 September 2003 on military service of professional soldiers (i.e. Journal of Laws of 2020, item 860, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places for the Doctoral School is set by the Rector by 31 May 2021 at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2021, the Scientific Discipline Councils will establish lists of potential supervisors along with research topics and immediately forward them to the Director for publication on the Doctoral School's website.

10. At the request of the Chairperson of the Council of Scientific Discipline, the Director may make changes to the list referred to in paragraph 9 by 31 July 2021.

Section II
Recruitment committee and qualification teams

§ 2

1. To conduct the recruitment procedure for the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Doctoral School's Admissions Committee, hereinafter referred to as the "Admissions Committee";
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "qualification team".
2. The Admission Committee and qualification teams are appointed by the Rector for the period from 16 March 2021 to 15 March 2022.
3. You are entitled to remuneration for your work in the recruitment committee and in the qualification team. In the decision referred to in paragraph 1, the Rector shall specify the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The recruitment committee consists of:
   1) chairman – director;
   2) one representative of the scientific discipline referred to in § 1 section 1;
   3) other persons reported by the Director;
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall, by 5 March 2021, submit to the Director the data of the representatives referred to in paragraph 1 point 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline.
3. At the request of the Chairperson of the Recruitment Committee, the Rector may appoint new members or dismiss already appointed members of the Recruitment Committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
7. Meetings of the committee may be held remotely. Decisions on the form of the meeting are made by the President.
8. The meetings of the recruitment committee are recorded. The minutes are signed by the Chairman and other members of the committee participating in the meeting.
9. The Recruitment Committee makes decisions in the form of resolutions. Resolutions are adopted by a simple majority of votes in an open vote, in the

presence of at least half of the members of the committee. In the event of an equal number of votes, the chairman's vote is decisive.

10. In the absence of the chairperson, the meeting of the committee shall be convened and chaired by a member of the committee authorised by the chairperson.
11. Tasks of the Recruitment Committee:
    1) supervision over the course of the recruitment procedure;
    2) preparing and submitting to the qualification teams a template of the protocol and individual candidate assessment sheets for the qualification teams;
    3) preparation of candidate documents for qualification teams;
    4) setting the dates of interviews within individual scientific disciplines;
    5) setting individual interview dates and notifying candidates;
    6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified to be entered on the list of doctoral students;
    7) publishing on the website of the Doctoral School a list of persons pre-qualified and, after verifying the declarations referred to in § 14 section 1, a list of persons admitted to the Doctoral School within individual scientific disciplines;
    8) preparation of decisions on refusal of admission to the Doctoral School.

§ 4

1. The qualification team of a scientific discipline includes:
    1) chairman;
    2) at least two members;
    3) secretary.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director by 5 March 2021 the data of candidates for:
    1) the chairperson and members of the team - from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline;
    2) secretary - from among the employees of the department related to the scientific discipline competent for the Council.
3. Tasks of qualification teams:
    1) analysis of candidates' documents provided by the recruitment committee;
    2) assessment of the compliance of the Master's degree programme completed by the candidate with the list of fields of study specified in Appendix No. 1 to the Recruitment Rules or an analysis of the candidates' scientific achievements referred to in § 6 section 2;
    3) analysis of qualifications, competences and scientific achievements of candidates and awarding ranking points in accordance with point 2 points 1-3 of Annex 3 to the recruitment rules;
    4) conducting an interview and awarding ranking points in accordance with point 2 point 4 of Appendix No. 3 to the Recruitment Rules,

5) determining the general, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 3 to the Recruitment Rules;
6) submission of the protocol to the Recruitment Committee together with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:
   a) pre-qualification of candidates for inclusion on the list of doctoral students;
   b) a proposal to change the limit of places for a scientific discipline;
   c) establishing a reserve list;
7) preparing information for the Recruitment Committee on the course of the selection procedure in the event of a candidate's request for reconsideration of the case.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairperson of the qualification team of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School.
3. A member of the qualification team is subject to exclusion from the assessment of the candidate, in particular if:
   1) has provided the candidate with the statement referred to in § 6 section 1 point 4;
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.
4. The Chairperson may exclude himself from the assessment of the candidate in the casesreferred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate shall be recorded in the protocol of the qualification team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 if they are:

1) hold the professional title of master's, master's degree in engineering or equivalent;
2) are graduates of fields of study providing second-cycle qualifications, hereinafter referred to as "master's studies", subject to paragraph 4, a detailed list of fields of study is contained in Appendix No. 1 to the Admission Rules;
3) meet the requirements set out in Article 186(1)(2) of the Act in terms of knowledge of a modern foreign language at the level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR);
4) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.

2. In exceptional cases, justified by the highest quality of scientific achievements, graduates of first-cycle studies or students who have completed the third year of long-cycle Master's studies meeting the requirements referred to in paragraph 1(3) and (4) may apply for admission to the Doctoral School.
3. In the absence of a master's degree due to waiting for its issuance, the candidate is obliged to present a certificate from the university on obtaining a master's degree.
4. In the case of a person holding a diploma of completion of a master's degree programme other than that listed in Appendix 1 to the rules of recruitment or studies completed outside Polish, the qualification team competent for the scientific discipline selected by the candidate decides whether the candidate has the competences necessary to apply for admission to the Doctoral School in a specific scientific discipline. The qualification team may ask the candidate to provide additional documents.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at the B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of a foreign language at the B2 level, they demonstrate knowledge of Polish, i.e.:
   1) complete a one-year preparatory course for taking up education in Polish in units designated by the minister competent for higher education, or
   2) have a certificate of knowledge of the Polish language issued by the State Commission for the Certification of Knowledge of Polish as a Foreign Language, or
   3) have completed their studies in Poland in a field of study conducted in Polish, or
   4) During the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:

1) registration of the candidate in the Internet Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee **– 9-22 August 2021;**
2) Qualification procedure – **23 August – 7 September 2021,** including:
   a) interviews – **30 August – 3 September 2021;**
3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 9 September 2021**;
4) issuance of an administrative decision on refusal to admit to the Doctoral School to candidates not qualified to be entered on the list of doctoral students **– 13-17 September 2021**;
5) submission by candidates pre-qualified to be entered on the list of doctoral students of the statement referred to in § 14 section 1 - **9-17 September 2021;**
6) announcement of the list of those admitted to the Doctoral School **- 22 September 2021**

2. The Recruitment Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the website of the Doctoral School by 15 July 2021.
3. The lists of candidates and admitted candidates referred to in paragraph 1 points 3 and 6 are published on the website of the Doctoral School.

Chapter III
Registration and documents to be filed

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) to familiarize yourself with these recruitment rules;
   2) preparing electronic versions of the documents referred to in paragraph 4;
   3) selecting a potential supervisor and the proposed research topic from the list referred to in § 1 section 9, conducting an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtaining a statement - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. Registration of candidates for the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the website of the Doctoral School and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to paragraphs 5 and 6:
   1) an application for admission to the Doctoral School generated from the IRK system and signed;
   2) a diploma confirming the obtaining of a master's degree, a master's degree in engineering or an equivalent degree;
   3) a supplement to the Master's degree or other document confirming the course of studies;
   4) a statement of a potential supervisor – according to the template contained in Appendix No. 2 to the Recruitment Rules;

5) a signed information questionnaire with attachments - according to the template contained in Appendix No. 4 to the Recruitment Rules;
6) curriculum vitae (CV);
7) a signed information clause concerning the processing of personal data – according to the template contained in Appendix No. 5 to the Recruitment Rules.

5. Candidates, beneficiaries of the "Diamond Grant" programme, in addition to the documents
referred to in paragraph 4, submit a document confirming that they have obtained the "Diamond Grant".
6. Candidates referred to in § 6 section 2 shall submit:
1) Documents referred to in paragraph 4 points 1 and 4-7;
2) a diploma confirming the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies;
3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act apply to the recognition of a diploma as entitling to undertake education at the Doctoral School.
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the Recruitment Committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.

Chapter IV
Enrolment fee

§ 9

1. The admission fee to the Doctoral School is PLN 200.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **August 22, 2021.**
3. In a particularly justified case, the candidate may, by 13 August 2021, submit an application to the Rector for exemption from the recruitment fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
4. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.
5. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 3 or the expiry of the deadline referred to in paragraph 4, the candidate shall not be subject to the qualification procedure.
6. The candidate is entitled – at his/her request – to a refund of the recruitment fee in the event of:
1) resignation from participation in the selection procedure before its commencement, i.e. before 23 August 2021;

2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by a qualification team appropriate for the scientific discipline selected by the candidate and includes:
   1) an analysis of the compliance of the Master's degree programme completed by the candidate with the list of fields of study included in Appendix No. 1 to the Admission Rules or, in the case of candidates referred to in § 6 section 2, an assessment of the quality of the candidate's scientific achievements and the relationship with one of the scientific disciplines indicated in § 1 section 1;
   2) awarding ranking points in the following criteria:
      a) the result of completing master's studies;
      b) qualifications and competences for education at the Doctoral School;
      c) scientific achievements;
      d) Interview.
2. The qualification team awards candidates with ranking points in individual criteria on the terms set out in Appendix 3 to the Recruitment Rules.
3. The qualification team, in the scope of the tasks specified in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee.
4. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c.
5. In the case of a beneficiary of the Diamond Grant programme, the qualification team shall award the candidate 60 points for the criteria referred to in paragraph 1(2)(a-c), irrespective of the candidate's results in those criteria.
6. The number of ranking points of the candidate for the criterion referred to in paragraph 1 point 2 letters b-d shall be the arithmetic average of the points awarded by the individual members of the qualification team, rounded up to one decimal place, and may not be greater than the maximum value specified for the criterion in question.
7. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 100 points.
8. After the completion of the selection procedure, the qualification team shall immediately submit to the recruitment committee the completed and signed documents referred to in § 3 section 11 point 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and his/her scientific interests

based on the presented research project and general knowledge of the scientific discipline.

2. Information on the date and place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 is provided to candidates electronically to the e-mail address indicated in the IRK system and is published on the website of the Doctoral School by 25 August 2021.
3. The interview can be conducted remotely using commonly available online tools.
4. Before the interview begins, the chair or secretary of the selection team is obliged to verify the identity of the candidate.
5. The interview consists of two parts:
    1) The first part – presentation by the candidate of a preliminary research project prepared in accordance with the research topic agreed with the potential supervisor – max. 10 min.;
    2) The second part – questions from the members of the qualification team aimed at checking the candidate's general knowledge in the field of the selected scientific discipline, the ability to justify/defend the presented research project, conduct a scientific discussion and motivation for research work.
6. The initial research project should include m.in:
    1) defining the research problem (objective, research questions, hypotheses);
    2) the proposed methodology;
    3) the state of research in the scope of the proposed project topic;
    4) reference to literature related to the subject of the project.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the Admission Committee may order the Qualification Team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only if he/she meets the formal requirements referred to in § 6 section 1, pays the recruitment fee in accordance with the conditions specified in § 9, receives a positive grade referred to in § 10 section 3 and obtains a total of at least 50 ranking points, including: at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 shall prevent the candidate from being entered on the ranking list of candidates even if the limit of places for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee prepares a protocol on the recruitment process, to which a document called the ranking list of candidates is attached, containing information about the candidates pre-qualified for entry on the list of doctoral students.

3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) the interview referred to in § 10 section 1 point 2 letter d;
   2) scientific achievements referred to in § 10 section 1 point 2 letter c;
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admissions committee.
6. In the case referred to in paragraph 5, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2021/2022.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) names and surnames of candidates;
   2) the number of ranking points awarded for the criteria referred to in point 1 of Appendix 3 to the Recruitment Rules;
   3) final result – the sum of the ranking points;
   4) indicate whether the candidate has been pre-qualified to be entered on the list of doctoral students of the Doctoral School.
9. The protocol is signed by the members of the recruitment committee who took part in the recruitment procedure, and the ranking list is signed by the chairperson of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the recruitment committee.

Chapter VII
Admission and Refusal of Admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after submitting a statement to the Dean's Office of the Doctoral School in paper form or sending it in electronic form (email: szkola.doktorska@wat.edu.pl) no later than by 17 September 2021 in accordance with the template specified in Appendix 6 to the Recruitment Rules.
2. Failure to meet the requirement specified in paragraph 1 results in the candidate being removed from the list of pre-qualified candidates for entry on the list of doctoral students and the admissions committee applying to the Rector for a decision on refusal of admission to the Doctoral School.
3. Candidates who have not been accepted due to the exhaustion of the limit of places constitute a reserve group. In the event of vacancies on the list of pre-qualified candidates for the Doctoral School for the academic year 2021/2022, these persons may, by the decision of the recruitment committee, be admitted to the Doctoral School in the order resulting from the number of points obtained.

4. The admissions committee immediately informs the candidate of admission in this manner. The provisions of paragraphs 1 and 2 shall apply accordingly, whereby the candidate is obliged to submit the declaration referred to in paragraph 1 within seven days from the date of providing information about this obligation, failing which the qualification will expire by law.

§ 15

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Special recruitment procedures for the WAT Doctoral School are conducted by the recruitment committee and qualification teams referred to in § 2 section 1 as separate competition procedures, outside the limits of places specified in § 1 section 8.
2. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activities of the admissions committee and qualification teams during a special recruitment procedure, the Rector may extend their activity until the end of this procedure.
3. Candidates recruited to the Doctoral School as part of a special recruitment procedure must meet both the formal criteria referred to in § 6 section 1 and the criteria specified for the programme, project, grant or agreement.
4. Candidates referred to in paragraph 3 may be admitted to the Doctoral School for the academic year 2021/2022 only on condition that they ensure, throughout the entire period of education, full funding from doctoral scholarship programmes, projects, grants or agreements in the amount of not less than the amount of the scholarship specified in Article 209(4) of the Act and a possible increase in the scholarship and co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.
5. The period of education referred to in paragraph 4 also includes the period of suspension of education and extension of the deadline for submitting a doctoral dissertation.
6. The condition for admission to the Doctoral School and the financing of the candidates referred to in paragraph 5 is an agreement specifying the conditions for the implementation, financing and settlement of financial resources for the financing of the scholarship or doctoral scholarships, the increase in the

amount of the scholarship or scholarships and the costs of social security incurred by WAT and, if applicable, the co-financing of the costs of using the research infrastructure, as well as the financing of activities related to the procedure
for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. The recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Science and Higher Education of 29 May 2019 on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for the implementation recruitment should be recruited primarily from among the employees of enterprises and other entities cooperating with the Military Academy.
3. By 31 March 2021, the Recruitment Committee determines:
   1) the schedule for conducting the implementation recruitment;
   2) a list and templates of documents submitted by a potential supervisor and candidate at each stage of recruitment;
   3) templates of protocols, research project evaluation cards and individual candidate evaluation cards for qualification teams;
   4) the manner and place or form of submission of documents.
4. Implementation recruitment is carried out by the recruitment committee and qualification teams in two stages:
   1) preliminary stage;
   2) final stage.
5. The initial stage includes:
   1) submission of documents by the candidate and potential supervisor;
   2) the Recruitment Committee submits documents to the competent qualification team for the scientific discipline;
   3) assessment by the qualifying team of the submitted research project;
   4) preliminary qualification procedure conducted by the qualification team, in the scope of:
      a) meeting the candidate's formal requirements for:
         - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'CC programme';
         - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 point 1;
      b) conduct an interview;
      c) awarding ranking points for the criteria referred to in §10 section 1 point 2;

d) provide the admissions committee with the documents referred to in paragraph 3(3) together with recommendations to the admissions committee regarding the qualification of the research project and the candidate for the DW programme.

6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in paragraph 5 point 4 letter a and obtain a minimum of 20 points from the interview.
7. Before accepting the protocols of the qualification teams, the admissions committee may commission the qualifying team to re-evaluate the research project or to analyze the documents and the method of awarding ranking points. This does not apply to points awarded for an interview.
8. The admissions committee prepares a protocol from the course of the preliminary stage, to which, in the case of positive acceptance of the project and candidates, it attaches a document called the ranking list of candidates, containing information about candidates pre-qualified for entry on the list of doctoral students under the DW program.
9. On the basis of the protocol of the recruitment committee from the preliminary stage:
   1) an application is submitted through the Integrated System of Services for Science Service of Funding Streams (ZSUN/OSF) to the minister responsible for higher education and science, hereinafter referred to as the "Minister",
   for the qualification of WAT for participation in the DW programme, or
   2) in the event of a negative assessment of the research project or a negative assessment of the candidate, the candidate receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2021/2022 as part of the programme.
10. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is placed on the website of the Doctoral School and sent to the candidate's e-mail address.
11. The final stage applies only to candidates who have been entered on the ranking list in the initial stage and includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee - within the deadline specified in § 7 section 1 point 1;
   2) the candidate provides documents for this stage, specified in paragraph 3 point 2;
   3) conducting the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 13;
   4) preparation of the final protocol from the implementation recruitment by the recruitment committee.
12. The admissions committee may, at any stage of the induction recruitment, call upon the candidate to submit additional documents confirming that they meet the requirements for participation in the DW program.
13. The final qualification is carried out only if the Minister provides information on the qualification of the WAT proposal for participation in the DW programme, together with information on the number of doctoral students who can be admitted to the Doctoral School under this programme in individual scientific

disciplines for the academic year 2021/2022 and the amount of financial resources broken down by academic years.

14. If the Minister provides information on the non-qualification of the WAT application for participation in the DW programme, the Rector issues a decision refusing to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
15. As a result of the final qualification, on the basis of the final protocol of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2021/2022 as part of the DW program, or
    2) receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2021/2022 under this programme.
16. Participation of a candidate in the induction recruitment does not exclude, at his/her request, participation in the recruitment to the Doctoral School for the academic year 2021/2022.

Chapter III
Other programs, projects, grants, agreements

§ 18

1. Special recruitment procedures may also be conducted under other programs, projects, grants or contracts.
2. The detailed rules of the procedures referred to in paragraph 1 shall be determined by the recruitment committee, at least 14 days before the start of the recruitment process, taking into account the candidates' fulfilment of the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or contract.
3. Selection procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions shall apply:
    1) Act;
    2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the recognition of diplomas of completion of studies abroad and confirmation of completion of studies at a certain level (Journal of Laws of 28 September 2018).item 1881);
    3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2020, item 256, as amended).

Appendix no. 1 to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

List of fields of study whose graduates may apply for admission to the Doctoral School

Scientific discipline conducted at the Doctoral School	Completed Master's degree
Automation, Electronics and Electrical Engineering	- Automation and robotics - electronics - Electronics & Telecommunications - electrical engineering - Energy - physics - Technical physics - Photonics - Materials Engineering - Mechatronics - computer science - Biomedical Engineering - Optoelectronics and Photonics - Aerospace and Satellite Engineering - nanotechnology - Optical Engineering
Technical Informatics and Telecommunications	- Automation and robotics - Electronics & Telecommunications - electrical engineering - computer science - Computer Science and Econometrics
Civil Engineer & Transportation	- Construction - Geodesy and Cartography - geophysics - geography - geology - physics - computer science - navigation - mathematics - Aerospace and Satellite Engineering
Materials Engineering	- chemistry - physics - Technical physics - chemical and process engineering - Materials Engineering - Production Engineering - mechanics and mechanical engineering - metallurgy - Chemical Technology
Mechanical Engineering	- Materials Engineering - logistics - mechanics and mechanical engineering - Mechatronics - transport - Production Management and Engineering - Automation and robotics - Technical physics - Aerospace
Chemical Sciences	- chemistry - Chemical Technology - chemical and process engineering - biotechnology - Materials Engineering - biochemistry - environmental protection - Environmental Engineering - physics
Security Sciences	- National security - internal security - European Studies - Safety Engineering - logistics - political science - international relations - management - National defence - State security management

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

……..
(degree)

……..
(name and surname of the potential supervisor)

……..
(scientific discipline represented)

……..
(Faculty)

STATEMENT

I declare that in the event of your admission:

.....
(name and surname of the candidate)

to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2021/2022, I hereby give preliminary consent to scientific supervision and acting as a supervisor within the research topics:

……
……
……
……
……
(research topics)

……. ……..
(date) *(signature of a potential supervisor)*

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

Detailed rules awarding ranking points to candidates

1. Qualification teams of individual scientific disciplines award candidates with ranking points according to criteria.

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in § 10 section 4 and 5 of the recruitment rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Interview	0 ÷ 40	0÷ 40
Total max.	**100**	

2. Detailed rules for awarding ranking points in individual criteria:
   1) The result of completing a master's degree.

Result	Number of points Ranked
5w	20
5	15
4+	10
4	5
less than 4	0

   2) Qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline.

Specification	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
3) certificate of foreign language proficiency above B2	2

   3) Scientific achievements of the candidate.

Specification	Number of Ranking Points
1) documented scientific publications published in the last 5 years, including:	**0 ÷ 30 points**
a) monograph	0 ÷ 15 pts for one monograph
b) chapter in a multi-author monograph	0 ÷ 5 pts per chapter – no more than 10 points in total
c) scientific publication in journals from the list of journals referred to in Article 267(2) of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list of journals referred to in point c	0 ÷ 5 pts for one publication – a total of no more than 15 points.
e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials	0 ÷ 5 pts for one publication – a total of no more than 10 points.
2) Documented awards or scholarships	**0 ÷ 15 pts**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one prize or scholarship
b) obtaining a Rector's Award or Scholarship	0 ÷ 3 points
c) Distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 pts**
a) distinction in the competition for the best student work within the activities of the KNS	0 ÷ 3 points;
b) distinction for speaking at the KNS seminar	0 ÷ 2 pts.
4) documented participation in research projects - based on statements made by research project managers	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF formats*
2. *In the event that the sum of points from the sub-criteria exceeds the maximum value for this criterion, the candidate is awarded the maximum number of points for this criterion*

4) Interview.

Specification	Number of Ranking Points
1) evaluation of the presented research project in the scope of: a) defining the research problem (goal, research questions, hypotheses), b) the proposed methodology, c) innovativeness and originality of the issues undertaken, d) presentation of the state of research in the field of design and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend your project, b) general knowledge in the field of scientific discipline, c) the ability to conduct scientific discussions, including consistency and transparency of argumentation, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

INFORMATION QUESTIONNAIRE

surname..... name.....

I. MASTER DATA

1. Completed second-cycle studies (master's)

a) University Name: .....

b) Completed field of study: .....

c) Result of completing master's studies: .....

d) No., date and place of issue of the diploma: .....

e) Title of diploma thesis: .....

.....

.....

f) title/academic degree, name and surname of the thesis supervisor

.....

2. Do you have a doctoral degree? If so, please attach a copy of your doctoral diploma or temporary certificate – *attachment no. 1*

3. Have you had or have you initiated a doctoral dissertation? If so, please indicate where and in which scientific discipline and the subject of the dissertation.

.....

.....

4. Current employment

.....

.....

(name of the workplace, town, position held)

II. QUALIFICATIONS AND COMPETENCES

1. Trips abroad and individual studies:

a) mobility within the framework of programs, e.g. Erasmus – *attachment no. 2*

.....

.....
(name of the programme, date of departure, semester of study, host university, country)

b) **Foreign internships – *Appendix No. 3***

.....
(name of traineeship, date, semester of study, host institution, country)

.....
(name of traineeship, date, semester of study, host institution, country)

c) **Individual studies - *attachment no. 4***

.....
(semester(s) of study, level of study)

.....
(semester(s) of study, level of study)

2. Certificates and certificates proving the acquisition of qualifications needed for scientific work - *Appendix No. 5*

.....
(name of certificate/attestation)

.....
(name of certificate/attestation)

.....
(name of certificate/attestation)

3. Document certifying knowledge of a foreign language at the level of language proficiency at least B2 - *attachment no. 6*[1]

.....
(name of the certificate/attestation, supplement to the first-cycle diploma)

4. Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Annex No. 7*[2]

.....
(document name)

---

[1] in the case of:
- certificate above B2, only this certificate should be attached,

[2] documents referred to in § 6 section 6 points 1-3

III. SCIENTIFIC ACHIEVEMENTS

1. Publication activity in the scientific discipline <u>in the last 5 years</u>[3]:

a) Monograph in the scientific discipline - ***<u>Appendix No. 8</u>***

……
(title, publisher, year of publication)

……
(title, publisher, year of publication)

b) Chapter in the multi-author monograph - ***<u>Appendix No. 9</u>***

……
(title, monograph title, publisher, year of publication)

……
(title, monograph title, publisher, year of publication)

……
(title, monograph title, publisher, year of publication)

c) scientific publication in journals from the list of scientific journals referred to in Article 267(2) of the Act - ***<u>Annex No. 10</u>***

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

d) scientific publication in journals outside the list of scientific journals referred to in Article 267(2) of the Act **- *<u>Annex No. 11</u>***

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

……
(title, journal name, year of publication)

[3] in the case of:
- monograph should be accompanied by a copy of the title page and an abstract (max. 5 pages). A4),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, the title page and the abstract (max. 3 pages). A4), a copy of the entire publication should be attached to 5 pages,

e) participation in a scientific conference with a presentation of the paper and its publication in peer-reviewed post-conference materials - ***attachment no. 12***

……
(name of the conference, date, place, topic of the presentation)

……
(name of the conference, date, place, topic of the presentation)

……
(name of the conference, date, place, topic of the presentation)

2. Awards, scholarships

a) awards or scholarships of the minister competent for higher education and science or the Minister of National Defence – ***attachment no. 13***

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

b) obtaining the Rector's award or scholarship – ***attachment no. 14***

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

……
(name of the award or scholarship, date of award)

c) Distinction for the best diploma thesis – ***attachment no. 15***

……
(engineering/bachelor's/master's thesis, date of award)

……
(engineering/bachelor's/master's thesis, date of award)

d) Other awards for research activities – ***Appendix No. 16***

……
(award title, date of award)

……
(award title, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

a) distinction in the competition for the best student work within the activities of the KNS – ***attachment no. 17***

……

……

……

(the topic of the work, the date of awarding the distinction)

b) distinction for speaking at the KNS seminar – ***attachment no. 18***

……

……

……

……

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title, degree, name and surname Manager Project	% of project participation

Comments:

- only attachments in pdf format are uploaded to the IRK system,
- the annex to the point/sub-point of the Questionnaire should contain a confirmation of all the information indicated in that point/sub-point,
- attachments should contain confirmations of awards, scholarships, distinctions obtained in the form of scans of diplomas, certificates, decisions,
- the candidate's participation in research projects is confirmed by a certificate from the principal investigator,
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

....

city, date signature of the candidate

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018. Law on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit and be admitted to the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and , subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Appendix No. 6
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2021/2022

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I hereby declare that as of **1 October 2021.**:

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology will be the only doctoral school where I will start my education;
2. I will not be employed as an academic or researcher;
3. I will/will not* be employed as an academic teacher or researcher under the conditions set out in Article 209(10)(1) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended);
4. I have/do not have* a doctoral degree;
5. I have/do not have* the certificate(s):
   1) about disability*,
   2) the degree of disability*, referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2018, item 511);

……..
legible signature

Attachments:

……
……
**- delete unnecessary*

Remark:

In the cases referred to in:

- *point 3 - information on the candidate's employment for the purpose of carrying out the research project referred to in Article 119(2)(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2020, item 85, as amended) should be attached),*
- *point 4 – a copy of the diploma conferring the academic degree of a doctor should be attached,*
- *point 5 – a copy of the decision should be attached.*

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 11/WAT/2022 of 24 February 2022

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended), in connection with § 21(1)(27) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021) The following is resolved:

§ 1

The "Rules of Recruitment to the Military University of Technology Doctoral School for the academic year 2022/2023" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

(-) Col. Prof. Przemysław Wachulak

Attachment
to Resolution No. ..../WAT/2022 of the WAT Senate
of 2022

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2022/2023

Section I
General

§ 1

1. The Doctoral School of the Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2022/2023, in the following scientific disciplines:
   1) automation, electronics and electrical engineering,
   2) technical informatics and telecommunications,
   3) civil engineering and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) safety sciences,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School is carried out by means of a competition in accordance with these Rules of Admission to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2022/2023, hereinafter referred to as the "Admission Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines, within the framework of which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as those applicable to Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for directing professional soldiers to the Doctoral School in the official mode are regulated by the provisions of the Act of 11 September 2003 on the military service of professional soldiers (i.e. Journal of Laws of 2021, item 1131, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places for the Doctoral School is set by the Rector by 31 May 2022, at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2022, the Scientific Discipline Councils will establish lists of potential supervisors along with research topics and immediately forward them to the Director for publication on the Doctoral School's website.

10. At the request of the Chairman of the Council of Scientific Discipline , the Director may make changes to the list referred to in paragraph 9 by 31 July 2022

Section II
Recruitment committee and qualification teams

§ 2

1. To conduct the recruitment procedure for the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Doctoral School's Admissions Committee, hereinafter referred to as the "Admissions Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "qualification team".
2. The Admission Committee and qualification teams are appointed by the Rector for the period from 16 March 2022 to 15 March 2023.
3. You are entitled to remuneration for your work in the recruitment committee and in the qualification team. In the decision referred to in paragraph 1, the Rector shall specify the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The recruitment committee consists of:
   1) chairman – director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the headteacher,
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. By 5 March 2022, the chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director the data of the representatives referred to in paragraph 1 point 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline.
3. At the request of the Chairperson of the Recruitment Committee, the Rector may appoint new or dismiss appointed members of the Recruitment Committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
7. Meetings of the committee may be held remotely. Decisions on the form of the meeting are made by the chairman of the recruitment committee.
8. The meetings of the recruitment committee are recorded. The minutes shall be signed by the chairperson of the recruitment committee and the members of the committee participating in the meeting, subject to paragraph 9.
9. In the case of a meeting of the committee conducted remotely, the minutes are signed only by the chairperson of the recruitment committee.
10. The Recruitment Committee makes decisions in the form of resolutions. Resolutions are adopted by a simple majority of votes in an open vote, in the

presence of at least half of the members of the committee. In the event of an equal number of votes, the vote of the chairman of the recruitment committee is decisive.

11. In the absence of the chairperson, the meeting of the committee shall be convened and chaired by a member of the committee authorised by the chairperson.
12. Tasks of the Recruitment Committee:
    1) supervision over the course of the recruitment procedure,
    2) preparing and submitting to the qualification teams a template of the protocol and individual candidate evaluation sheets for the qualification teams,
    3) preparation of candidate documents for qualification teams,
    4) setting the dates of interviews within individual scientific disciplines,
    5) setting individual interview dates and notifying candidates,
    6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified to be included in the list of doctoral students,
    7) publishing on the website of the Doctoral School a list of pre-qualified persons and, after verifying the declarations referred to in § 14 section 1, a list of those admitted to the Doctoral School within individual scientific disciplines,
    8) preparation of decisions on refusal of admission to the Doctoral School.

§ 4

1. The qualification team of a scientific discipline includes:
    1) chairman
    2) at least two members,
    3) secretary.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1, shall, by 5 March 2022, submit to the Director the data of candidates for:
    1) the chairperson and members of the team - from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline,
    2) secretary - from among the employees of the department related to the scientific discipline competent for the Council.
3. Tasks of qualification teams:
    1) analysis of candidates' documents submitted by the recruitment committee,
    2) analysis and assessment of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
    3) analysis of qualifications, competences and scientific achievements of candidates and awarding ranking points in accordance with point 2 points 1-3 of Annex No. 1 to the recruitment rules,
    4) analysis of the concept of the candidates' doctoral dissertation and awarding of ranking points in accordance with point 2 point 4 of Annex No. 1 to the recruitment rules,

5) conducting an interview and awarding ranking points in accordance with point 2 point 5 of Appendix No. 1 to the Recruitment Rules.
6) determining the total, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the Recruitment Rules,
7) submission of the protocol to the Recruitment Committee together with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:
   a) pre-qualification of candidates for inclusion on the list of doctoral students,
   b) a proposal to change the limit of places for a scientific discipline,
   c) establishing a reserve list,
8) preparing information for the Recruitment Committee on the course of the selection procedure in the event of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and members of the qualification team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairperson of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairperson of the qualification team of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School.
3. A member of the qualification team is subject to exclusion from the assessment of the candidate, in particular if:
   1) has provided the candidate with the statement referred to in § 6 section 1 point 3,
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.
4. The Chairperson may exclude himself from the assessment of the candidate in the cases referred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate shall be recorded in the protocol of the qualification team.

Section III
Recruitment procedure

Chapter I

Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 if they are:
   1) have a master's degree, a master's degree in engineering or an equivalent degree,
   2) have a documented knowledge of English at the level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 4 – the list of documents confirming knowledge of English at the level of at least B2 is contained in Appendix No. 5 to the Recruitment Rules
   3) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. In exceptional cases, justified by the highest quality of scientific achievements, graduates of first-cycle studies or students who have completed the third year of long-cycle master's studies meeting the requirements referred to in paragraph 1 points 2 and 3 may apply for admission to the Doctoral School.
3. In the absence of a master's degree due to waiting for its issuance, the candidate is obliged to present a certificate from the university on obtaining a master's degree.
4. A certificate is not required for native English speakers.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at the B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of Polish, i.e.:
   1) complete a one-year preparatory course for taking up education in Polish in units designated by the minister competent for higher education, or
   2) have a certificate of knowledge of the Polish language issued by the State Commission for the Certification of Knowledge of Polish as a Foreign Language, or
   3) have completed their studies in Poland in a field of study conducted in Polish, or
   4) During the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Internet Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee **– 1-14 August 2022,**
   2) Qualification procedure – **15 August – 2 September 2022,** including:
      a) interviews – **August 29 – September 2, 2022,**

3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 8 September 2022**,
4) issuance of an administrative decision on refusal to admit to the Doctoral School to candidates not qualified for inclusion on the list of doctoral students **– 12-15 September 2022**,
5) submission by candidates pre-qualified for inclusion on the list of doctoral students of the statement referred to in § 14 section 1 – **8-16 September 2022,**
6) announcement of the list of those admitted to the Doctoral School **- September 22, 2022**

2. The Recruitment Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2022.
3. The lists of candidates and admitted candidates referred to in paragraph 1 points 3 and 6 are published on the website of the Doctoral School.

Chapter III
Registration and documents to be filed

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) familiarize yourself with these recruitment rules,
   2) prepare electronic versions of the documents referred to in paragraph 4,
   3) selecting a potential supervisor and the proposed research topic from the list referred to in § 1 section 9, conducting an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtaining a statement - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. Registration of candidates for the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the website of the Doctoral School and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to paragraphs 5 and 6:
   1) an application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the obtaining of a master's degree, a master's degree in engineering or an equivalent degree,
   3) a diploma supplement or other document confirming the course of studies,
   4) a statement of a potential supervisor – according to the template contained in Appendix No. 2 to the Recruitment Rules,
   5) the concept of the doctoral dissertation – according to the template contained in Appendix No. 3 to the Recruitment Rules,
   6) a signed information questionnaire with attachments - according to the template contained in Appendix 4 to the Recruitment Rules,
   7) curriculum vitae (CV);

8) a signed information clause regarding the processing of personal data – according to the template contained in Appendix No. 6 to the Recruitment Rules.

5. Candidates, beneficiaries of the "Diamond Grant" programme, in addition to the documents
   referred to in paragraph 4, submit a document confirming that they have obtained the "Diamond Grant".
6. Candidates referred to in § 6 section 2 shall submit:
   1) documents referred to in paragraph 4 points 1 and 4-7,
   2) a diploma confirming the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies,
   3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act apply to the recognition of a diploma as entitling to undertake education at the Doctoral School.
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the Recruitment Committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.

Chapter IV
Enrolment fee

§ 9

1. The admission fee to the Doctoral School is PLN 200.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **August 15, 2022.**
3. In a particularly justified case, the candidate may, by 5 August 2022, submit an application to the Rector for exemption from the recruitment fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
4. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.
5. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 3 or the expiry of the deadline referred to in paragraph 4, the candidate shall not be subject to the qualification procedure.
6. The candidate is entitled – at his/her request – to a refund of the recruitment fee in the event of:
   1) resignation from participation in the qualification procedure before its commencement, i.e. before 15 August 2022;
   2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by a qualification team appropriate for the scientific discipline selected by the candidate and includes:
   1) analysis and evaluation of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
   2) awarding ranking points in the following criteria:
      a) the result of completing master's studies,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) the concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards candidates with ranking points in individual criteria on the terms set out in Appendix No. 1 to the Recruitment Rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the event of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside Polish, the qualification team competent for the scientific discipline selected by the candidate may ask the candidate to submit additional documents.
5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c.
6. In the case of a beneficiary of the Diamond Grant programme, the qualification team shall award the candidate 60 points for the criteria referred to in paragraph 1(2)(a-c), irrespective of the candidate's results in those criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b-e) shall be the arithmetic average of the points awarded by each member of the qualification team, rounded up to one decimal place, and shall not exceed the maximum value specified for the criterion in question.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the end of the selection procedure, the qualification team shall immediately submit to the recruitment committee the completed and signed documents referred to in § 3 section 12 point 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and his/her scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date and place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 is provided to candidates

electronically to the e-mail address indicated in the IRK system and is published on the website of the Doctoral School by 19 August 2022.

3. The interview can be conducted remotelyusing commonly available online tools. The preferred messenger is MS Teams.
4. Before the interview begins, the chair or secretary of the selection team is obliged to verify the identity of the candidate.
5. The interview consists of two parts:
    1) the first part – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) The second part – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the introductory topic of the doctoral dissertation,
    2) justification for the choice of topic, results of the analysis of the state of knowledge in the field of selected research issues, literature review,
    3) initial definition of the research problem (objective, research questions, hypotheses),
    4) the proposed methodology,
    5) expected results,

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the Admission Committee may order the Qualification Team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the case of:
    1) meeting the formal requirements referred to in § 6 section 1,
    2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
    3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
    4) obtaining a total of at least 55 ranking points, including at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 shall prevent the candidate from being entered on the ranking list of candidates even if the limit of places for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee prepares a protocol on the recruitment process, to which a document called the ranking list of candidates is attached, containing

information about the candidates pre-qualified for entry on the list of doctoral students.

3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admissions committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2022/2023.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) names and surnames of candidates,
   2) the result of the assessment of the relationship between the Master's degree programme, other forms of education and scientific achievements completed by the candidate and the scientific discipline of his/her choice,
   3) the number of ranking points awarded for the criteria referred to in point 1 of Appendix 1 to the Recruitment Rules,
   4) final result – the sum of the ranking points,
   5) indicate whether the candidate has been pre-qualified to be entered on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the recruitment committee.

Chapter VII
Admission and Refusal of Admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after submitting a statement to the Dean's Office of the Doctoral School in paper form or sending it in electronic form (email: szkola.doktorska@wat.edu.pl) no later than by 17 September 2022 in accordance with the template specified in Appendix No. 7 to the Recruitment Rules.
2. Failure to meet the requirement specified in paragraph 1 results in the candidate being removed from the list of pre-qualified candidates for entry on the list of doctoral students and the admissions committee applying to the Rector for a decision on refusal of admission to the Doctoral School.
3. Candidates who have not been accepted due to the exhaustion of the limit of places constitute a reserve group. In the event of vacancies on the list of pre-

qualified candidates for the Doctoral School for the academic year 2022/2023, these persons may, by the decision of the recruitment committee, be admitted to the Doctoral School in the order resulting from the number of points obtained.

4. The admissions committee immediately informs the candidate of admission in this manner. The provisions of paragraphs 1 and 2 shall apply accordingly, whereby thecandidate is obliged to submit the declaration referred to in paragraph 1 within seven days from the date of providing information about this obligation, failing which the qualification will expire by law.

§ 15

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School under a special recruitment procedure takes place as a separate competition procedure, outside the limits of places specified in § 1 section 8, the rules of which take into account these recruitment rules and the rules specified for the programme, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. The common rules of recruitment are approved by the chairperson of the recruitment committee after agreement with the representatives of the competent institution or the manager of the programme, project, grant or contract
3. Special recruitment procedures for the Doctoral School may be conducted by the Admission Committee and the qualification teams referred to in § 2 section 1, subject to paragraphs 4 and 5.
4. The meetings of the selection teams and the selection committee as part of the special recruitment procedure may be attended by the representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred
   to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activities of the admissions committee and qualification teams during a special recruitment procedure, the Rector may extend their activity until the end of this procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2022/2023 only on condition that they ensure, throughout the entire period of education, full funding from doctoral scholarship programmes, projects, grants or agreements in the

amount of not less than the amount of the scholarship specified in Article 209(4) of the Act, and a possible increase in the scholarship and co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.

8. The period of education referred to in paragraph 6 also includes the period of suspension of education and extension of the deadline for submitting a doctoral dissertation.
9. The condition for admission to the Doctoral School and the financing of the candidates referred to in paragraph 6 is an agreement specifying the conditions for the implementation, financing and settlement of financial resources for the financing of the scholarship or doctoral scholarships, the increase in the amount of the scholarship or scholarships and the costs of social security incurred by the Military University of Technology and, if applicable, the co-financing of the costs of using the research infrastructure, as well as the financing of activities related to the procedure for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. The recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Education and Science of 16 April 2021 on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for the implementation recruitment should be recruited primarily from among the employees of enterprises and other entities cooperating with the Military Academy.
3. By 31 March 2022, the Recruitment Committee determines:
   1) schedule of implementation recruitment,
   2) a list and templates of documents submitted by a potential supervisor and candidate at each stage of recruitment,
   3) templates of protocols, evaluation cards for the concept of the doctoral dissertation, cards for the evaluation of scientific achievements of the potential supervisor in the field of the subject selected by the candidate and individual evaluation cards for qualification teams,
   4) the manner and place or form of submission of documents.
4. Implementation recruitment is carried out by the recruitment committee and qualification teams in two stages:
   1) preliminary stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee - within the deadline specifiedin the schedule referred to in paragraph 3 point 1,
   2) submission of documents by the recruitment committee to the qualification team competent for the scientific discipline,

3) analysis and evaluation by the qualification team of the submitted topic of the doctoral dissertation and the scientific achievements of the potential supervisor,
4) Qualification proceedings conducted by the qualification team, in the scope of:
   a) meeting the candidate's formal requirements for:
      - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'CC programme',
      - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 point 1,
   b) conducting an interview,
   c) awarding ranking points for the criteria referred to in §10 section 1 point 2,
   d) provide the admissions committee with the documents referred to in paragraph 3(3) together with recommendations to the admissions committee regarding the qualification of the research project and the candidate for the DW programme.

6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in paragraph 5(4)(a) and obtain a minimum of 20 points from the interview.
7. Before accepting the protocols of the qualification teams, the admissions committee may commission the qualifying team to re-evaluate the research project or to analyze the documents and the method of awarding ranking points. This does not apply to points awarded for an interview.
8. The admissions committee prepares a protocol from the course of the preliminary stage, to which, in the case of positive acceptance of the project and candidates, it attaches a document called the ranking list of candidates, containing informationabout candidates pre-qualified for entry on the list of doctoral students under the DW program.
9. On the basis of the protocol of the recruitment committee from the preliminary stage:
   1) is submitted, through the Integrated System of Services for Science Servicing Funding Streams (ZSUN/OSF), an application to the minister responsible for higher education and science, hereinafter referred to as the "Minister"
      , for the qualification of a candidate for participation in the DW programme, or
   2) in the event of a negative assessment of the research project or a negative assessment of the candidate, the Rector receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2022/2023 as part of the programme.
10. The applications referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.
11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is placed on the website of the Doctoral School and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the initial stage and includes:
   1) the candidate provides documents for this stage, specified in paragraph 3 point 2,

2) conducting the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 13,
3) preparation of the final protocol from the implementation recruitment by the recruitment committee.

13. The admissions committee may, at any stage of the induction recruitment, call upon the candidate to submit additional documents confirming that they meet the requirements for participation in the DW program.
14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application for participation in the DW programme, together with information on the number of doctoral students who may be admitted to the Doctoral School under this programme in individual scientific disciplines for the academic year 2022/2023 and the amount of financial resources broken down by academic years.
15. If the Minister provides information on the non-qualification of the WAT application for participation in the DW programme, the Rector issues a decision refusing to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final protocol of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2022/2023 as part of the DW program, or
    2) receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2022/2023 under this programme.
17. The candidate's participation in the induction recruitment does not exclude, at his or her request, participation in the recruitment to the Doctoral School for the academic year 2022/2023.

Chapter III
Other programs, projects, grants, agreements

§ 18

1. Special recruitment procedures may also be conducted under other programs, projects, grants or contracts.
2. The detailed rules of the procedures referred to in paragraph 1 shall be determined by the recruitment committee, at least 14 days before the start of the recruitment process, taking into account the candidates' fulfilment of the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or contract.
3. Selection procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions shall apply:
    1) Act
    2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the recognition of diplomas of completion of studies abroad and

confirmation of completion of studies at a certain level (Journal of Laws of 28 September 2018).item 1881),

3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2021, item 735, as amended).

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

Detailed rules awarding ranking points

1. Qualifying teams award ranking points to candidates according to the following criteria:

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in § 10 section 5 and 6 of the Recruitment Rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Doctoral dissertation concept	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. Detailed rules for awarding ranking points in individual criteria:

1) Result of completion of the master's degree

Result	Number of points Ranked
very good with distinction (5w)	20
very good (5)	15
a good plus (4+)	10
Good (4)	5
Below Good (Under 4)	0

2) Qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline

Specification	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, etc.)	0 ÷ 3
3) certificate of foreign language proficiency above B2	2

3) Candidate's scientific achievements

Specification	Number of Ranking Points
1) documented scientific publications published in 2017-2022, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267(3) of the Act	0 ÷ 15 pts for one monograph
b) a chapter in a multi-author monograph from the list referred to in Article 267(3) of the Act	0 ÷ 5 pts per chapter – no more than 10 points in total
c) scientific publication in journals from the list referred to in Article 267(3) of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 15 points.
e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 10 points.
2) Documented awards or scholarships	**0 ÷ 15 pts**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one prize or scholarship
b) obtaining a Rector's Award or Scholarship	0 ÷ 3 points
c) Distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 pts**
1. distinction in the competition for the best student work within the activities of the KNS	0 ÷ 3 points;
2. distinction for speaking at the KNS seminar	0 ÷ 2 pts.
4) documented participation in research projects - based on statements made by research project managers	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF formats*
2. *In the event that the sum of points from the sub-criteria exceeds the maximum value for this criterion, the candidate is awarded the maximum number of points for this criterion*

4) Doctoral dissertation concept

Specification	Number of Ranking Points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the dissertation topic and the justification for its selection, the definition of the research problem, aim, research questions, hypotheses, methodology and the presentation of the current state of research in the scope of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Number of Ranking Points
1) evaluation of the presentation of the doctoral dissertation concept in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) the proposed methodology, d) innovativeness and originality of the issues undertaken, e) presentation of the state of research in the field of design and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct scientific discussions, including consistency and transparency of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

(degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

(university/organisational unit)

STATEMENT

I declare that in the event of your admission:

(name and surname of the candidate)

to the Doctoral School of the Military University of Technology for the academic year 2022/2023, I hereby give preliminary consent to scientific supervision and acting as a supervisor within the research topics:

(research topics)

…….
(date)

……..
(signature of a potential supervisor)

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

(name and surname of the candidate)

(scientific discipline)

Doctoral dissertation concept[1]

……..
legible signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, defining: the research problem, aim, research questions, hypotheses, methodology and presenting the current state of research in the scope of the adopted subject matter - max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. MASTER DATA

1st Completed second-cycle studies (master's)

1)	name of the University	
2)	Field of study	
3)	Completion Score	
4)	Year of completion	
5)	title of the diploma thesis	
6)	name and surname of the thesis supervisor	

2nd Do you have a doctoral degree? If <u>so</u>, please attach a copy of your doctoral diploma or provisional certificate – *<u>attachment no. 1</u>*

3rd Have you been/been a participant in doctoral studies (third-cycle studies)? If <u>yes</u> , please specify the university/institute, scientific discipline, year of start - year of completion

4th Have you had or have you initiated a doctoral dissertation? If so, please specify the university/institute and scientific discipline and the topic of the dissertation.

5. Current employment

(name of the workplace, town, position held, status - professional soldier, police officer, prison service, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1st Trips abroad and individual studies:

1) mobility within the framework of programs, e.g. Erasmus – *<u>attachment no. 2</u>*

(name of the programme, date of departure, semester of study, host university, country)

2) Foreign internships – ***Appendix No. 3***

(name of traineeship, date, semester of study, host institution, country)

3) Individual studies - *attachment no. 4*

(semester(s) of study, level of study)

2nd Certificates and certificates proving the acquisition of qualifications needed for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3rd Document certifying knowledge of English at the level of language proficiency at least B2 - *attachment no. 6*[2]

(name of the certificate/attestation, supplement to the first-cycle diploma)

4th Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Annex No. 7*[3]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1st Publication activity in the years 2017 - 2022[4]:

1) monograph from the list referred to in Article 267(3) of the Act - ***Annex No. 8***

(author(s), title, publisher, year of publication, number of points)

2) a chapter in a multi-author monograph, from the list referred to in Article 267(3) of the Act - ***Appendix No. 9***

[2] in the case of:
- records certifying language proficiency at the B2 level in the supplement to the first-cycle diploma should be accompanied by this supplement
- certificate above B2, only this certificate should be attached,

[3] documents referred to in § 6 section 6 points 1-3

[4] in the case of:
- monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, the title page and abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

(author(s), title, monograph title, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267(3) of the Act - ***Annex No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267(3) of the Act - ***Annex No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication in peer-reviewed post-conference materials, in the list referred to in Article 267(3) of the Act - ***Annex No. 12***

(conference name, date, place, presentation topic, author(s)

2. Awards, scholarships

1) awards or scholarships of the minister competent for higher education and science or the Minister of National Defence – ***attachment no. 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***attachment no. 14***

(name of the award or scholarship, date of award)

3) Distinction for the best diploma thesis – ***attachment no. 15***

(engineering/bachelor's/master's thesis, date of award)

4) Other awards for research activities – ***Appendix No. 16***

(award title, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

1) distinction in the competition for the best student work within the activities of the KNS – ***attachment no. 17***

(the topic of the work, the date of awarding the distinction)

2) distinction for speaking at the KNS seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title/degree name and surname Manager Project	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the annex to the point/sub-point of the Questionnaire should contain a confirmation of all the information indicated in that point/sub-point,
- attachments should contain confirmations of awards, scholarships, distinctions obtained in the form of scans of diplomas, certificates, decisions,
- The candidate's participation in research projects is confirmed by the principal investigator's certificate, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, date	*Candidate's signature*

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

List
documents confirming knowledge of English
at least B2

In the recruitment procedure for the WAT Doctoral School, the following documents are accepted by the candidate confirming his/her knowledge of English at the level of at least B2 on the global language proficiency scale according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)":

1. Certificates issued by institutions affiliated to the Association of Language Testers in Europe (ALTE) – ALTE Level 3 (B2), ALTE Level 4 (C1), ALTE Level 5 (C2), in particular:
   1) First Certificate in English (FCE) or B2 First (FCE),
   2) Certificate in Advanced English (CAE) or C1 Advanced (CAE),
   3) Certificate of Proficiency in English (CPE) or C2 Proficiency (CPE),
   4) Business English Certificate (BEC) Vantage – at least Pass,
   5) Business English Certificate (BEC) Higher,
   6) Certificate in English for International Business and Trade (CEIBT);
2. Certificates from the following institutions:
   1) Educational Testing Service (ETS) – in particular certificates:
      a) Test of English as a Foreign Language (TOEFL) – at least 87 points in the Internet-Based Test (iBT) version,
      b) Test of English as a Foreign Language (TOEFL) – at least 180 points in the Computer-Based Test (CBT) version, supplemented by at least 50 points in the Test of Spoken English (TSE),
      c) Test of English as a Foreign Language (TOEFL) – at least 510 points in the Paper-Based Test (PBT), supplemented by at least 3.5 points in the Test of Written English (TWE) and at least 50 points in the Test of Spoken English (TSE),
      d) Test of English for International Communication (TOEIC) – at least 700 points;
   2) European Consortium for the Certificate of Attainment in Modern Languages (ECL);
   3) City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute – in particular certificates:
      a) English for Speakers of Other Languages (ESOL) – First Class Pass at Intermediate Level, Higher Intermediate Level, Advanced Level,
      b) International English for Speakers of Other Languages (IESOL) – "Communicator" level, "Expert" level, "Mastery" level,
      c) City & Guilds Level 1 Certificate in ESOL International (reading, writing and listening) Communicator (B2) 500/1765/2,

d) City & Guilds Level 2 Certificate in ESOL International (reading, writing and listening) Expert (C1) 500/1766/4,
e) City & Guilds Level 3 Certificate in ESOL International (reading, writing and listening) Mastery (C2) 500/1767/6,
f) Spoken English Test (SET) for Business – Stage B level "Communicator", Stage C level "Expert", Stage C level "Mastery",
g) English for Business Communications (EBC) – Level 2, Level 3,
h) English for Office Skills (EOS) – Level 2;

4) Edexcel, Pearson Language Tests, Pearson Language Assessments – in particular certificates:
a) London Tests of English, Level 3 (Edexcel Level 1 Certificate in ESOL International),
b) London Tests of English, Level 4 (Edexcel Level 2 Certificate in ESOL International),
c) London Tests of English, Level 5 (Edexcel Level 3 Certificate in ESOL International);

5) Education Development International (EDI), London Chamber of Commerce and Industry Examinations Board – in particular certificates:
a) London Chamber of Commerce and Industry Examinations (LCCI) – English for Business Level 2, English for Business Level 3, English for Business Level 4,
b) London Chamber of Commerce and Industry Examinations (LCCI) – Foundation Certificate for Teachers of Business English (FTBE),
c) London Chamber of Commerce and Industry Examinations (LCCI) – English for Tourism Level 2;

6) University of Cambridge ESOL Examinations, British Council, IDP IELTS Australia – in particular certificates:
a) International English Language Testing System IELTS – above 6 points,

7) telc GmbH, WBT Weiterbildungs-Testsysteme GmbH – in particular certificates:
a) B2 Certificate in English – advantage,
b) B2 Certificate in English for Business Purposes – advantage,
c) Certificate in English for Technical Purposes (B2),
d) telc English B2,
e) telc English B2 Business,
f) telc English B2 Technical,

3. Academic certificates issued by universities associated in the Association of Academic Centres for Teaching Foreign Languages SERMO – levels B2 and C1, in particular:
1) ACERT B2,
2) ACERT B2 Business English,
3) ACERT C1.
4. Certificate confirming knowledge of a foreign language issued by the National School of Public Administration as a result of a linguistic examination procedure.
5. Certificates confirming the achievement of at least the level of SPJ 3333 knowledge of English according to the NATO Standardization Agreement STANAG 6001.

6. Diplomas of completion of studies in the field of English Philology.
7. Information in the supplement to the diploma of graduation about passing the English language exam at the level of at least B2.
8. Diplomas containing a graphic sign indicating level 6 or 7. of the Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language pursued during the studies was English and the learning outcomes were achieved for English.
9. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
10. A document issued abroad considered equivalent to a secondary school leaving certificate if the language of instruction was English.
11. International Baccalaureate Diploma or European Baccalaureate.
12. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
13. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the possession of sworn translator qualifications in another Member State of the European Union, a member state of the European Free Trade Agreement (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
14. Other certificates, certificates, diplomas not mentioned above – if during the recruitment procedure the qualification team obtains the approval of the Head of the Head of the Technical University of Technology's Foreign Language Studies.

Appendix No. 6
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018. Law on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit and be admitted to the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and , subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Appendix No. 7
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2022/2023

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **1 October 2022.**:

1. The Doctoral School of the Military University of Technology will be the only doctoral school where I will start my education;
2. I will not be employed as an academic or researcher;
3. I will/will not* be employed as an academic teacher or researcher under the conditions set out in Article 209(10)(1) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended);
4. I have/do not have* a doctoral degree;
5. I have/do not have* the certificate(s):
   1) about disability*,
   2) on the degree of disability* referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2021, as amended);

……..
legible signature of the candidate

Attachments:

……
……
**- delete unnecessary*

Remark:

In the cases referred to in:

- *point 3 - information on the candidate's employment for the purpose of carrying out a research project referred to in Article 119(2)(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2021, item 478, as amended) should be attached),*
- *point 4 – a copy of the diploma conferring the academic degree of a doctor should be attached,*
- *point 5 – a copy of the decision should be attached.*

Wojskowa Akademia Techniczna

Resolution
Senate of the Military University of Technology
No. 28/WAT/2023 of 23 February 2023

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended), in connection with § 21(1)(27) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021) The following is resolved:

§ 1

The "Rules of Recruitment to the Military University of Technology Doctoral School for the academic year 2023/2024" *is hereby defined,* constituting an annex to the resolution.

§ 2

The resolution enters into force on the day of its adoption.

President of the Senate

/-/ Brig. Gen. Prof. Przemysław Wachulak

Attachment
to Resolution No. 28/WAT/2023 of the WAT Senate
of 23 February 2023

Rules of recruitment
to the Doctoral School of the Military University of Technology for the academic year 2023/2024

Section I
General

§ 1

1. The Doctoral School of the Jarosław Dąbrowski of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2023/2024, in the following scientific disciplines:
   1) automation, electronics, electrical engineering and space technologies,
   2) technical informatics and telecommunications,
   3) civil engineering, geodesy and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) safety sciences,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School is carried out by means of a competition in accordance with these Rules of Admission to the Doctoral School of the Military University of Technology for the academic year 2023/2024, hereinafter referred to as the "Recruitment Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines, within the framework of which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as those applicable to Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for the referral of professional soldiers to the Doctoral School are regulated by the provisions of the Act of 11 March 2022 on the Defence of the Homeland (i.e. Journal of Laws of 2022, item 655, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places for the Doctoral School is set by the Rector by 31 May 2023, at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2023, the Scientific Discipline Councils will establish lists of potential supervisors along with the thematic scope of the research and immediately forward them to the Director for publication on the Doctoral School's website.
10. At the request of the Chairman of the Scientific Discipline Council , the Director may make changes to the list referred to in paragraph 9 by 31 July 2023

Section II
Recruitment committee and qualification teams

§ 2

1. To conduct the recruitment procedure for the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Doctoral School's Admissions Committee, hereinafter referred to as the "Admissions Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "qualification team".
2. The Admission Committee and qualification teams are appointed by the Rector for the period from 20 March 2023 to 15 March 2024.
3. You are entitled to remuneration for your work in the recruitment committee and in the qualification team. In the decision referred to in paragraph 1, the Rector shall specify the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The recruitment committee consists of:
   1) chairman – director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the headteacher,
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. By 6 March 2023, the chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director the data of the representatives referred to in paragraph 1 point 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline.
3. At the request of the Chairperson of the Recruitment Committee, the Rector may appoint new or dismiss appointed members of the Recruitment Committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the admissions of the recruitment committee as an observer.
5. The administrative service of the admissions committee is provided by the Dean's Office of the Doctoral School.
6. The chairperson of the admissions committee convenes the admissions committee meetings and chairs its deliberations.
7. Meetings of the committee may be held remotely. Decisions on the form of the meeting are made by the chairman of the recruitment committee.
8. The meetings of the recruitment committee are recorded. The minutes shall be signed by the chairperson of the recruitment committee and the members of the committee participating in the meeting, subject to paragraph 9.
9. In the case of a meeting of the committee conducted remotely, the minutes are signed only by the chairperson of the recruitment committee.
10. In the absence of the chairperson, the meeting of the committee shall be convened and chaired by a member of the committee authorised by the chairperson.
11. Tasks of the Recruitment Committee:
    1) supervision over the course of the recruitment procedure,

2) preparing and submitting to the qualification teams a template of the protocol and individual candidate evaluation sheets for the qualification teams,
3) preparation of candidate documents for qualification teams,
4) setting the dates of interviews within individual scientific disciplines,
5) setting individual interview dates and notifying candidates,
6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified to be included in the list of doctoral students,
7) publishing on the website of the Doctoral School a list of persons who have been pre-qualified and, after verifying the documents referred to in § 14 section 1, a list of persons admitted to the Doctoral School within individual scientific disciplines,
8) preparation of decisions on refusal of admission to the Doctoral School.

§ 4

1. The qualification team of a scientific discipline includes:
   1) chairman
   2) at least two members,
   3) secretary.
2. The chairpersons of the Councils of Scientific Disciplines referred to in § 1 section 1 shall submit to the Director by 6 March 2023 the data of candidates for:
   1) the chairperson and members of the team - from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline,
   2) secretary - from among the employees of the department related to the scientific discipline competent for the Council.
3. Tasks of qualification teams:
   1) analysis of candidates' documents submitted by the recruitment committee,
   2) analysis and assessment of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
   3) analysis of qualifications, competences and scientific achievements of candidates and awarding ranking points in accordance with point 2 points 1-3 of Annex No. 1 to the recruitment rules,
   4) analysis of the concept of the candidates' doctoral dissertation and awarding of ranking points in accordance with point 2 point 4 of Annex No. 1 to the recruitment rules,
   5) conducting an interview and awarding ranking points in accordance with point 2 point 5 of Appendix No. 1 to the Recruitment Rules.
   6) determining the total, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the Recruitment Rules,
   7) submission of the protocol to the Recruitment Committee together with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:

a) pre-qualification of candidates for inclusion on the list of doctoral students,
b) a proposal to change the limit of places for a scientific discipline,
c) establishing a reserve list,

8) preparing information for the Recruitment Committee on the course of the selection procedure in the event of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and members of the qualification team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairperson of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairperson of the qualification team of any circumstances that may affect his/her impartiality and objectivity in assessing candidates for the Doctoral School.
3. A member of the qualification team is subject to exclusion from the assessment of the candidate , in particular if:
   1) has provided the candidate with the statement referred to in § 6 section 1 point 3,
   2) was the supervisor of the candidate's master's thesis;
   3) is the candidate's supervisor or is in another employment relationship with him;
   4) the candidate is or was his/her spouse or is a relative or relative up to the second degree, or remains or has been cohabiting with a member of the recruitment committee;
   5) the candidate is or has been associated with a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to maintaining impartiality and objectivity in the assessment of the candidate.
4. The Chairperson may exclude himself from the assessment of the candidate in the cases referred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate shall be recorded in the protocol of the qualification team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 if they are:
   1) have a master's degree, a master's degree in engineering or an equivalent degree,

2) have a documented knowledge of English at the level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 4 – the list of documents confirming knowledge of English at the level of at least B2 is contained in Appendix No. 5 to the Recruitment Rules
3) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.

2. In exceptional cases, justified by the highest quality of scientific achievements, graduates of first-cycle studies or students who have completed the third year of long-cycle master's studies meeting the requirements referred to in paragraph 1 points 2 and 3 may apply for admission to the Doctoral School.
3. In the absence of a master's degree due to waiting for its issuance, the candidate is obliged to present a certificate from the university on obtaining a master's degree.
4. A certificate is not required for native English speakers.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at the B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of Polish, i.e.:
   1) complete a one-year preparatory course for taking up education in Polish in units designated by the minister competent for higher education, or
   2) have a certificate of knowledge of the Polish language issued by the State Commission for the Certification of Knowledge of Polish as a Foreign Language, or
   3) have completed their studies in Poland in a field of study conducted in Polish, or
   4) During the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.
7. If the Master's degree was issued in a language other than Polish or English, the candidate must attach a sworn translation.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Internet Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee **– 1-15 August 2023,**
   2) Qualification procedure – **August 16 - September 7, 2023,** including:
      a) interviews – **August 28 – September 1, 2023,**
   3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 8 September 2023**,
   4) issuance of an administrative decision on refusal to admit to the Doctoral School to candidates not qualified to be entered on the list of doctoral students **– 12-15 September 2023**,

5) submission by candidates pre-qualified to be entered on the list of doctoral students of the documents referred to in § 14 section 1 – **8-18 September 2023,**
6) announcement of the list of those admitted to the Doctoral School **- September 20, 2023**

2. The Admission Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2023.
3. The lists of candidates and admitted candidates referred to in paragraph 1 points 3 and 6 are published on the website of the Doctoral School.

Chapter III
Registration and documents to be filed

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) familiarize yourself with these recruitment rules,
   2) prepare electronic versions of the documents referred to in paragraph 4,
   3) selecting a potential supervisor and the proposed scope of research topics from the list referred to in § 1 section 9, conducting an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtaining a statement - the template of the statement is contained in Appendix No. 2 to the Recruitment Rules.
2. Registration of candidates for the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the website of the Doctoral School and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to paragraphs 5 and 6:
   1) an application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the obtaining of a master's degree, a master's degree in engineering or an equivalent degree,
   3) a diploma supplement or other document confirming the course of studies,
   4) a statement of a potential supervisor – according to the template contained in Appendix No. 2 to the Recruitment Rules,
   5) the concept of the doctoral dissertation – according to the template contained in Appendix No. 3 to the Recruitment Rules,
   6) a signed information questionnaire with attachments - according to the template contained in Appendix 4 to the Recruitment Rules,
   7) a document certifying knowledge of English at the level of language proficiency at least B2 – the list of documents is contained in Appendix No. 5 to the Recruitment Rules;
   8) curriculum vitae (CV);
   9) a signed information clause regarding the processing of personal data – according to the template contained in Appendix No. 6 to the Recruitment Rules.

5. Candidates, beneficiaries of the "Diamond Grant" programme, in addition to the documentsreferred to in paragraph 4, submit a document confirming that they have obtained the "Diamond Grant".
6. Candidates referred to in § 6 section 2 shall submit:
   1) documents referred to in paragraph 4 points 1 and 4-7,
   2) a diploma confirming the professional title of engineer or bachelor or a certificate of completion of the third year of long-cycle master's studies,
   3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming obtaining a second-level qualification outside Polish must additionally submit a translation of the diploma prepared by a sworn translator. The provisions of Articles 326 and 327 of the Act apply to the recognition of a diploma as entitling to undertake education at the Doctoral School.
8. In the event of submitting incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the Recruitment Committee calls on the candidate to complete them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the set deadline results in the candidate's application being left unexamined, and thus the candidate will not be admitted to the selection procedure.

Chapter IV
Enrolment fee

§ 9

1. The admission fee to the Doctoral School is PLN 200.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **August 15, 2023.**
3. In a particularly justified case, the candidate may, by 5 August 2023, submit an application to the Rector for exemption from the recruitment fee at the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submission of the application.
4. In the event of refusal to waive the fee, the candidate is obliged to pay the recruitment fee within 7 days of providing this information.
5. In the event of failure to pay within the deadline referred to in paragraph 2 or failure to submit the application referred to in paragraph 3 or the expiry of the deadline referred to in paragraph 4, the candidate shall not be subject to the qualification procedure.
6. The candidate is entitled – at his/her request – to a refund of the recruitment fee in the event of:
   1) resignation from participation in the selection procedure before its commencement, i.e. before 15 August 2023;
   2) refusal to initiate the qualification procedure in relation to the candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by a qualification team appropriate for the scientific discipline selected by the candidate and includes:
   1) analysis and evaluation of the relationship between the candidate's Master's degree programme, other forms of education and scientific achievements and the scientific discipline of his/her choice,
   2) awarding ranking points in the following criteria:
      a) the result of completing master's studies,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) the concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards candidates with ranking points in individual criteria on the terms set out in Appendix No. 1 to the Recruitment Rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the event of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside Polish, the qualification team competent for the scientific discipline selected by the candidate may ask the candidate to submit additional documents.
5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c.
6. In the case of a beneficiary of the Diamond Grant programme, the qualification team shall award the candidate 60 points for the criteria referred to in paragraph 1(2)(a-c), irrespective of the candidate's results in those criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b-e) shall be the arithmetic average of the points awarded by each member of the qualification team, rounded up to one decimal place, and shall not exceed the maximum value specified for the criterion in question.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the completion of the selection procedure, the qualification team shall immediately submit to the recruitment committee the completed and signed documents referred to in § 3 section 11 point 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and his/her scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date and place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 is provided to candidates

electronically to the e-mail address indicated in the IRK system and is published on the website of the Doctoral School by 21 August 2023.

3. The interview can be conducted in a stationary or remote form using commonly available online tools. The preferred messenger is MS Teams.
4. Before the interview begins, the chair or secretary of the selection team is obliged to verify the identity of the candidate.
5. The interview consists of two parts:
    1) the first part – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) The second part – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the introductory topic of the doctoral dissertation,
    2) justification for the choice of topic, results of the analysis of the state of knowledge in the field of selected research issues, literature review,
    3) initial definition of the research problem (objective, research questions, hypotheses),
    4) the proposed methodology,
    5) expected results.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the Admission Committee may order the Qualification Team to re-analyze the documents and the method of awarding the ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the case of:
    1) meeting the formal requirements referred to in § 6 section 1,
    2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
    3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
    4) obtaining a total of at least 55 ranking points, including at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 makes it impossible to enter a candidate on the ranking list of candidates even if the limit of places specified for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee prepares a protocol on the recruitment process, to which a document called the ranking list of candidates is attached, containing

information about the candidates pre-qualified for entry on the list of doctoral students.

3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admissions committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2023/2024.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) name and surnames of the candidate,
   2) final result – the sum of the ranking points,
   3) indicate whether the candidate has been pre-qualified to be entered on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should contain a justification and be confirmed by the signature of the chairman of the recruitment committee.

Chapter VII
Admission and Refusal of Admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after being delivered to the Dean's Office of the Doctoral School no later than by 18 September 2023.
   1) statements in accordance with the template specified in Annex 7 to the Recruitment Rules,
   2) a diploma of completion of second-cycle studies, long-cycle master's studies or equivalent obtained on the basis of separate regulations or a certificate of obtaining a master's degree.
2. In special cases, the chairperson of the selection committee may set a deadline for other candidates to submit the documents referred to in paragraph 1.
3. Failure to meet the requirements set out in paragraph 1 results in the candidate being removed from the list of those pre-qualified for inclusion on the list of doctoral students and the admissions committee applying to the Rector for a decision on refusal to admit him to the Doctoral School.
4. Candidates who meet the conditions referred to in § 12 section 2 and have not been admitted due to the exhaustion of the limit of places specified for the scientific discipline constitute a reserve group. In the event of vacancies on the

list of pre-qualified candidates for the Doctoral School for the academic year 2023/2024 in the scientific discipline chosen by the candidate, these persons may, by the decision of the Rector, be admitted to the Doctoral School in the order resulting from the number of points obtained.

5. The admissions committee immediately informs the candidate of admission in this manner. The provisions of paragraphs 1 and 2 shall apply accordingly, whereby thecandidate is obliged to submit the declaration referred to in paragraph 1 within seven days from the date of providing information about this obligation, failing which the qualification will expire by law.

§ 15

1. Admission to the Doctoral School takes place by entering the list of doctoral students.
2. Admission to the Doctoral School is refused by way of an administrative decision of the Rector at the request of the admissions committee. The Rector's decision may be subject to a request for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School under a special recruitment procedure takes place as a separate competition procedure, outside the limits of places specified in § 1 section 8, the rules of which take into account these recruitment rules and the rules specified for the programme, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. The common rules of recruitment are approved by the chairperson of the recruitment committee after agreement with the representatives of the competent institution or the manager of the programme, project, grant or contract
3. Special recruitment procedures for the Doctoral School are conducted by the Admission Committee and the qualification teams referred to in § 2 section 1, subject to paragraphs 4 and 5.
4. The meetings of the selection teams and the selection committee as part of the special recruitment procedure may be attended by the representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activities of the admissions committee and qualification teams during a special recruitment procedure, the Rector may extend their activity until the end of this procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2023/2024 only on condition that they ensure, throughout the entire period of education, full funding from doctoral scholarship programmes, projects, grants or agreements in the

amount of not less than the amount of the scholarship specified in Article 209(4) of the Act and a possible increase in the scholarship and co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.

8. The period of education referred to in paragraph 6 also includes the period of suspension of education and extension of the deadline for submitting a doctoral dissertation.
9. The condition for admission to the Doctoral School and financing of the candidates referred to in paragraph 7 is an agreement specifying the conditions for the implementation, financing and settlement of financial resources for the financing of the scholarship or doctoral scholarships, the increase in the amount of the scholarship or scholarships and the costs of social security incurred by WAT and, if necessary, the co-financing of the costs of using the research infrastructure, as well as the financing of activities related to the procedurefor the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Education and Science on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for implementation recruitment should be recruited from among the employees of enterprises and other entities cooperating with the Military Military Academy.
3. By 31 March 2023, the Recruitment Committee determines:
   1) schedule of implementation recruitment,
   2) a list and templates of documents submitted by a potential supervisor and candidate at each stage of recruitment,
   3) the manner and place or form of submission of documents.
4. Implementation recruitment is carried out by the recruitment committee and qualification teams in two stages:
   1) preliminary stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee referred to in § 9 section 1 and 2, within the deadline specified in the schedule referred to in paragraph 3 point 1,
   2) submission of documents by the recruitment committee to the qualification team competent for the scientific discipline,
   3) Qualification proceedings conducted by the qualification team, in the scope of:
      a) analysis and evaluation of the topic of the doctoral dissertation submitted by the candidate and the scientific achievements of the potential supervisor,

b) meeting the candidate's formal requirements for:
   - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'CC programme',
   - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 point 1,
c) conducting an interview,
d) awarding ranking points for the criteria referred to in §10 section 1 point 2,
e) provide the admissions committee with the documents referred to in subsection 3(3) together with recommendations to the admissions committee regarding the candidate's qualifications for the DW programme.

6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in paragraph 5(3)(b), obtain a positive assessment referred to in paragraph 5(3)(a) and score a minimum of 20 points from the interview.
7. Prior to accepting the protocols of the qualification teams, the Selection Committee may order the qualification team to re-conduct the qualification procedure referred to in paragraph 5(a), (b) and (d).
8. The admissions committee prepares a protocol of the course of the initial stage, to which, in the case of positive acceptance of the candidates, it attaches a document called the ranking list, containing information about the candidates pre-qualified for entry on the list of doctoral students under the DW program.
9. On the basis of the protocol of the recruitment committee from the preliminary stage:
   1) is submitted, through the Integrated System of Services for Science Servicing Funding Streams (ZSUN/OSF), an application to the minister responsible for higher education and science, hereinafter referred to as the "Minister"
   , for the qualification of a candidate for participation in the DW programme, or
   2) in the event of failure to meet the requirements referred to in paragraph 6, the candidate receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2023/2024 as part of the programme.
10. The applications referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.
11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is placed on the website of the Doctoral School and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the initial stage and includes:
   1) the candidate provides documents for this stage, specified in paragraph 3 point 2,
   2) conducting the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 14,
   3) preparation of the final protocol from the implementation recruitment by the recruitment committee.
13. The admissions committee may, at any stage of the induction recruitment, call upon the candidate to submit additional documents confirming that they meet the requirements for participation in the DW program.

14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application to participate in the DW programme for the academic year 2023/2024.
15. If the Minister provides information on the non-qualification of the WAT application for participation in the DW programme, the Rector issues a decision refusing to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final protocol of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2023/2024 as part of the DW program, or
    2) receives the Rector's decision to refuse admission to the Doctoral School for the academic year 2023/2024 under this programme.
17. Participation of a candidate in the induction recruitment does not exclude, at his or her request, participation in the recruitment to the Doctoral School for the academic year 2023/2024.

Chapter III
Other programs, projects, grants, agreements

§ 18

1. Special recruitment procedures may also be conducted under other programs, projects, grants or contracts.
2. The detailed rules of the procedures referred to in paragraph 1 shall be determined by the recruitment committee, at least 14 days before the start of the recruitment process, taking into account the candidates' fulfilment of the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or contract.
3. Selection procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions shall apply:
    1) Act
    2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the recognition of diplomas of completion of studies abroad and confirmation of completion of studies at a certain level (Journal of Laws of 28 September 2018).item 1881),
    3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2022, item 2000, as amended).

Appendix No. 1
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

Detailed rules awarding ranking points

1. **Qualifying teams award ranking points to candidates according to the following criteria:**

Criterion	Number of points Ranked	
1. Result of completion of the master's degree	0 ÷ 20	60 points in the case of candidates referred to in § 10 section 5 and 6 of the Recruitment Rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0 ÷ 30	
4. Doctoral dissertation concept	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. **Detailed rules for awarding ranking points in individual criteria:**
   1) **Result of completion of the master's degree**

Result	Number of points Ranked
very good with distinction (5w)	20
very good (5)	15
a good plus (4+)	10
Good (4)	5
Below Good (Under 4)	0

   2) **Qualifications and competences of the candidate for education at the Doctoral School in the selected scientific discipline**

Specification	Number of Ranking Points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and certificates proving the acquisition of qualifications needed for scientific work (postgraduate studies, courses, training, certificate of any foreign language above B2, etc.)	0 ÷ 5

3) Candidate's scientific achievements

Specification	Number of Ranking Points
1) documented scientific publications published in the years 2016-2023, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267(3) of the Act	0 ÷ 15 pts for one monograph
b) a chapter in a multi-author monograph from the list referred to in Article 267(3) of the Act	0 ÷ 5 pts per chapter – no more than 10 points in total
c) scientific publication in journals from the list referred to in Article 267(3) of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 15 points.
e) participation in a scientific conference with the presentation of a paper and its publication in peer-reviewed post-conference materials referred to in Article 267(3) of the Act	0 ÷ 5 pts for one publication – a total of no more than 10 points.
2) Documented awards or scholarships	**0 ÷ 15 pts**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one prize or scholarship
b) obtaining a Rector's Award or Scholarship	0 ÷ 3 points
c) Distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 pts**
1. distinction in the competition for the best student work within the activities of the KNS	0 ÷ 3 points;
2. distinction for speaking at the KNS seminar	0 ÷ 2 pts.
4) documented participation in research projects - based on statements made by research project managers	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF formats*
2. *In the event that the sum of points from the sub-criteria exceeds the maximum value for this criterion, the candidate is awarded the maximum number of points for this criterion*

4) Doctoral dissertation concept

Specification	Number of Ranking Points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the dissertation topic and the justification for its selection, the definition of the research problem, aim, research questions, hypotheses, methodology and the presentation of the current state of research in the scope of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Number of Ranking Points
1) evaluation of the presentation of the doctoral dissertation concept in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) the proposed methodology, d) innovativeness and originality of the issues undertaken, e) presentation of the state of research in the field of design and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct scientific discussions, including consistency and transparency of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

(degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

(university/organisational unit)

STATEMENT

I declare that in the event of your admission:

(name and surname of the candidate)

to the Doctoral School of the Military University of Technology for the academic year 2023/2024, I give preliminary consent to scientific supervision and acting as a supervisor within the research topics:

(research topics)

……. ……..
(date) *(signature of a potential supervisor)*

Appendix No. 3
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

(name and surname of the candidate)

(scientific discipline)

Doctoral dissertation concept[1]

……..
legible signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, defining: the research problem, aim, research questions, hypotheses, methodology and presenting the current state of research in the scope of the adopted subject matter - **max. 5000 characters without spaces,** Arial font, normal style, size 12, margins: right, left, top, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. MASTER DATA

1st Completed second-cycle studies (master's)

1)	name of the university	
2)	Field of study	
3)	Completion Score	
4)	Year of completion	
5)	title of the diploma thesis	
6)	name and surname of the thesis supervisor	

2nd Do you have a doctoral degree? If <u>so</u>, please attach a copy of your doctoral diploma or provisional certificate – *<u>attachment no. 1</u>*

3rd Have you had or have initiated a doctoral procedure or a procedure for awarding a doctoral degree? If so, please specify the university/institute and scientific discipline and the topic of the dissertation.

4th Have you been or are you a participant in doctoral studies (third-cycle studies)? If <u>yes</u> , please specify the university/institute, scientific discipline, year of start - year of completion

5th Have you been or are you a PhD student at a doctoral school? If <u>so</u> , please provide the name of the doctoral school, scientific discipline, date of commencement and end of education

6th Current employment

(name of the workplace, town, position held, status - professional soldier, police officer, prison service, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1st Trips abroad and individual studies:

1) **mobility within the framework of programs, e.g. Erasmus – *attachment no. 2***

(name of the programme, date of departure, semester of study, host university, country)

2) **Foreign internships – *Appendix No. 3***

(name of traineeship, date, semester of study, host institution, country)

3) **Individual studies - *attachment no. 4***

(semester(s) of study, level of study)

2nd Certificates and certificates proving the acquisition of qualifications needed for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3rd Document certifying knowledge of a foreign language at the level of language proficiency above B2 - *attachment no. 6*[1]

(name of certificate/attestation)

4th Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Annex No. 7*[2]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1st Publication activity in the years 2016 - 2023[3]:

1) monograph from the list referred to in Article 267(3) of the Act - ***Annex No. 8***

(author(s), title, publisher, year of publication, number of points)

[1] documents confirming knowledge of any foreign language at a level above B2, e.g. C1, C2, above SPJ 3333

[2] documents referred to in § 6 section 6 points 1-3

[3] in the case of:

- monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, the title page and abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

2) a chapter in a multi-author monograph, from the list referred to in Article 267(3) of the Act - ***Appendix No. 9***

(author(s), title, monograph title, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267(3) of the Act - ***Annex No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267(3) of the Act - ***Annex No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication
in peer-reviewed post-conference materials, in the list referred to in Article 267(3) of the Act - ***Annex No. 12***

(conference name, date, place, presentation topic, author(s)

2nd Awards, scholarships

1) awards or scholarships of the minister competent for higher education and science or the Minister of National Defence – ***attachment no. 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***attachment no. 14***

(name of the award or scholarship, date of award)

3) Distinction for the best diploma thesis – ***attachment no. 15***

(engineering/bachelor's/master's thesis, date of award)

4) Other awards for research activities – ***Appendix No. 16***

(award title, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

1) distinction in the competition for the best student work within the activities of the KNS – ***attachment no. 17***

(the topic of the work, the date of awarding the distinction)

2) distinction for speaking at the KNS seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution in which the project is carried out	Title/degree name and surname Manager Project	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the annex to the point/sub-point of the Questionnaire should contain a confirmation of all the information indicated in that point/sub-point,
- attachments should contain confirmations of awards, scholarships, distinctions obtained in the form of scans of diplomas, certificates, decisions,
- The candidate's participation in research projects is confirmed by the principal investigator's certificate, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, date	*Candidate's signature*

Appendix No. 5
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

List
documents confirming knowledge of English
at least B2

In the recruitment procedure for the WAT Doctoral School, the following documents are accepted by the candidate confirming his/her knowledge of English at the level of at least B2 on the global language proficiency scale according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)":

1. Certificates issued by institutions affiliated to the Association of Language Testers in Europe (ALTE) – ALTE Level 3 (B2), ALTE Level 4 (C1), ALTE Level 5 (C2), in particular:
   1) First Certificate in English (FCE) or B2 First (FCE),
   2) Certificate in Advanced English (CAE) or C1 Advanced (CAE),
   3) Certificate of Proficiency in English (CPE) or C2 Proficiency (CPE),
   4) Business English Certificate (BEC) Vantage – at least Pass,
   5) Business English Certificate (BEC) Higher,
   6) Certificate in English for International Business and Trade (CEIBT);
2. Certificates from the following institutions:
   1) Educational Testing Service (ETS) – in particular certificates:
      a) Test of English as a Foreign Language (TOEFL) – at least 87 points in the Internet-Based Test (iBT) version,
      b) Test of English as a Foreign Language (TOEFL) – at least 180 points in the Computer-Based Test (CBT) version, supplemented by at least 50 points in the Test of Spoken English (TSE),
      c) Test of English as a Foreign Language (TOEFL) – at least 510 points in the Paper-Based Test (PBT), supplemented by at least 3.5 points in the Test of Written English (TWE) and at least 50 points in the Test of Spoken English (TSE),
      d) Test of English for International Communication (TOEIC) – at least 700 points;
   2) European Consortium for the Certificate of Attainment in Modern Languages (ECL);
   3) City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute – in particular certificates:
      a) English for Speakers of Other Languages (ESOL) – First Class Pass at Intermediate Level, Higher Intermediate Level, Advanced Level,
      b) International English for Speakers of Other Languages (IESOL) – "Communicator" level, "Expert" level, "Mastery" level,
      c) City & Guilds Level 1 Certificate in ESOL International (reading, writing and listening) Communicator (B2) 500/1765/2,

d) City & Guilds Level 2 Certificate in ESOL International (reading, writing and listening) Expert (C1) 500/1766/4,
e) City & Guilds Level 3 Certificate in ESOL International (reading, writing and listening) Mastery (C2) 500/1767/6,
f) Spoken English Test (SET) for Business – Stage B level "Communicator", Stage C level "Expert", Stage C level "Mastery",
g) English for Business Communications (EBC) – Level 2, Level 3,
h) English for Office Skills (EOS) – Level 2;

4) Edexcel, Pearson Language Tests, Pearson Language Assessments – in particular certificates:
a) London Tests of English, Level 3 (Edexcel Level 1 Certificate in ESOL International),
b) London Tests of English, Level 4 (Edexcel Level 2 Certificate in ESOL International),
c) London Tests of English, Level 5 (Edexcel Level 3 Certificate in ESOL International);

5) Education Development International (EDI), London Chamber of Commerce and Industry Examinations Board – in particular certificates:
a) London Chamber of Commerce and Industry Examinations (LCCI) – English for Business Level 2, English for Business Level 3, English for Business Level 4,
b) London Chamber of Commerce and Industry Examinations (LCCI) – Foundation Certificate for Teachers of Business English (FTBE),
c) London Chamber of Commerce and Industry Examinations (LCCI) – English for Tourism Level 2;

6) University of Cambridge ESOL Examinations, British Council, IDP IELTS Australia – in particular certificates:
a) International English Language Testing System IELTS – above 6 points,

7) telc GmbH, WBT Weiterbildungs-Testsysteme GmbH – in particular certificates:
a) B2 Certificate in English – advantage,
b) B2 Certificate in English for Business Purposes – advantage,
c) Certificate in English for Technical Purposes (B2),
d) telc English B2,
e) telc English B2 Business,
f) telc English B2 Technical,

3. Academic certificates issued by universities associated in the Association of Academic Centres for Teaching Foreign Languages SERMO – levels B2 and C1, in particular:
1) ACERT B2,
2) ACERT B2 Business English,
3) ACERT C1.
4. Certificate confirming knowledge of a foreign language issued by the National School of Public Administration as a result of a linguistic examination procedure.
5. Certificates confirming the achievement of at least the level of SPJ 3333 knowledge of English according to the NATO Standardization Agreement STANAG 6001.

6. Diplomas of completion of studies in the field of English Philology.
7. Information in the supplement to the diploma of graduation about passing the English language exam at the level of at least B2.
8. Diplomas containing a graphic sign indicating level 6 or 7. of the Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language pursued during the studies was English and the learning outcomes were achieved for English.
9. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
10. A document issued abroad considered equivalent to a secondary school leaving certificate if the language of instruction was English.
11. International Baccalaureate Diploma or European Baccalaureate.
12. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
13. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the possession of sworn translator qualifications in another Member State of the European Union, a member state of the European Free Trade Agreement (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
14. Other certificates, certificates, diplomas not mentioned above – if they are approved by the Head of the Head of the Military University of Technology's Foreign Language Department.

Appendix No. 6
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

Information clause

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of the processing of personal data, who can be contacted via e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for the purposes of recruitment to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes.
4. The data provided will be processed on the basis of the provisions of law, i.e. the GDPR and the Act of 20 July 2018. Law on Higher Education and Science.
5. Providing data is voluntary, but necessary to achieve the purposes for which they were collected. Failure to provide them will make it impossible to recruit and be admitted to the first year of education at the Doctoral School.
6. Personal data will not be made available to other recipients, with the exception of the minister responsible for higher education and science, the Minister of National Defence and cases provided for by law.
7. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
8. You have the right to access the content of your data and , subject to the provisions of law: the right to rectify, delete, limit processing.
9. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
10. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the President of the Office for Personal Data Protection, if they believe that the processing of personal data violates generally applicable regulations in this regard.

I confirm that I have read and acknowledge the above information.

....
city, date *legible signature of the candidate*

Appendix No. 7
to the Rules of Admission to the Doctoral School of the Military University of Technology
for the academic year 2023/2024

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **1 October 2023.**:

1. The Doctoral School of the Military University of Technology will be the only doctoral school where I will carry out my education;
2. I will/will not* be employed as an academic teacher/researcher*[1];
3. I have/do not have* a doctoral degree[2];
4. I have/do not have* the certificate(s):[3]
   1) about disability*,
   2) on the degree of disability*, referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2021, item 573, as amended).

……..
legible signature of the candidate

Attachments:

1. ……
2. ……

**- delete unnecessary*

[1] the candidate may be employed as an academic teacher or researcher only in the case of employment for the purpose of carrying out a research project referred to in Article 119(2)(2) and (3) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2022, item 574, as amended) – in this case, information on the candidate's employment should be attached
[2] in the case of holding a doctoral degree, a copy of the diploma conferring the doctoral degree or a provisional certificate must be attached
[3] If you have a certificate, you should attach a copy of it

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology
Jarosław Dąbrowski

No. 11/WAT/2024 of 29 February 2024

on the determination of the rules of recruitment
to the Doctoral School of the Military University of Technology
Jarosław Dąbrowski for the academic year 2024/2025

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2023, item 742, as amended),
in connection with § 21 section 1 point 27 of the Statute of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), it is hereby resolved, as follows:

§ 1

The "Rules of recruitment to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2024/2025" *are hereby defined,* constituting an attachment to the resolution.

§ 2

The resolution shall enter into force on the date of its adoption.

W zastępstwie przewodniczącego Senatu

(-) prof. dr hab. inż. Jerzy MAŁACHOWSKI

Attachment
to Resolution No. 11/WAT/2024 of the Senate of the Military University of Technology
of 29 February 2024

Recruitment rules
for the Doctoral School of the Military University of Technology Jarosław Dąbrowski for the academic year 2024/2025

Section I
General

§ 1

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology, hereinafter referred to as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2024/2025, in the following scientific disciplines:
   1) automation, electronics, electrical engineering and space technologies,
   2) technical information technology and telecommunications,
   3) civil engineering, geodesy and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) security sciences,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School takes place through a competition in accordance
   with these Recruitment Rules for the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2024/2025, hereinafter referred to as the "recruitment rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines within which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School takes place on the same terms as for Polish citizens, taking into account the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2023, item 742, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for sending professional soldiers to the Doctoral School in the service mode are regulated by the provisions of the Act of 11 March 2022 on the Defence of the Homeland (i.e. Journal of Laws of 2022, item 2305, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places in the Doctoral School is determined by the Rector by 31 May 2024, at the request of the Director of the Doctoral School, hereinafter referred to as the "Director".
9. By 31 May 2024, the Councils of Scientific Disciplines will establish lists of potential supervisors along with the thematic scope of research.

10. The Councils for Scientific Disciplines may amend the lists referred to in paragraph 9 by 31 July 2024.
11. The resolutions referred to in paragraphs 9 and 10 shall be immediately forwarded by the Chairman of the Scientific Discipline Council to the Director.

Section II
Selection committee and selection teams

§ 2

1. To conduct the recruitment procedure to the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Admission Committee of the Doctoral School, hereinafter referred to as the "Admission Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "Qualification Team".
2. The admissions committee and qualification teams are appointed by the Rector for the period from 1 April 2024 to 31 March 2025.
3. Work in the recruitment committee and in the qualification team is remunerated. In the decision referred to in paragraph 1, the Rector lays down the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The admissions committee consists of:
   1) chairman – the director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the head,
   4) secretary – Head of the Dean's Office of the Doctoral School.
2. By 15 March 2024, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 section 1 shall provide the Director with the data of the representatives referred to in paragraph 1 item 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity within the scope of this scientific discipline.
3. At the request of the chairperson of the admissions committee, the rector may appoint new or dismiss appointed members of the admissions committee.
4. A representative appointed by the Doctoral Students' Self-Government may participate in the deliberations of the Admission Committee as an observer.
5. Administrative support for the recruitment committee is provided by the Dean's Office of the Doctoral School.
6. The chairman of the admissions committee convenes meetings of the admissions committee and chairs its meetings.
7. Committee meetings may be held remotely. Decisions on the form of the meeting are made by the chairman of the admissions committee.
8. Meetings of the admissions committee are recorded. The minutes are signed by the chairman of the admissions committee and the members of the committee participating in the meeting, subject to paragraph 9.
9. In the case of a committee meeting conducted remotely, the minutes are signed only by the chairman of the admission committee.

10. In the absence of the chairman, the committee meeting is convened and chaired by a committee member authorized by the chairman.
11. Tasks of the admissions committee:
    1) supervision over the recruitment procedure,
    2) preparing and providing qualification teams with a template of the protocol and individual candidate evaluation cards for qualification teams,
    3) preparation of candidate documents for qualification teams,
    4) setting the dates of interviews within individual scientific disciplines,
    5) setting individual dates for interviews and notifying candidates,
    6) determining, on the basis of the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified for entry on the list of doctoral students,
    7) publication on the Doctoral School's website of the list of pre-qualified persons and, after verification of the documents referred to in § 14 section 1, the list of persons admitted to the Doctoral School within individual scientific disciplines,
    8) preparation of a decision on refusal of admission to the Doctoral School.

§ 4

1. The qualification team for a scientific discipline includes:
    1) chairman
    2) at least two members,
    3) secretary.
2. By 15 March 2024, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 section 1 shall provide the Director with the data of candidates for:
    1) the chairperson and members of the team – from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity in the field of this scientific discipline,
    2) secretary - from among the employees of the faculty related to the scientific discipline appropriate for the Council.
3. Tasks of the qualification teams:
    1) analysis of candidates' documents submitted by the recruitment committee,
    2) analysis and assessment of the relationship between the candidate's completed master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
    3) analysis of qualifications and competences as well as scientific achievements of candidates and awarding ranking points in accordance with point 2 subsections 1-3 of Appendix No. 1 to the recruitment rules,
    4) analysis of the concept of the doctoral dissertation of the candidates and awarding ranking points in accordance with point 2 subsection 4 of Annex 1 to the recruitment rules,
    5) conducting an interview and awarding ranking points in accordance with point 2 subsection 5 of Appendix No. 1 to the recruitment rules.

6) determining the general, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the recruitment rules,
7) Submission of the protocol to the Recruitment Committee along with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:
   a) pre-qualification of candidates for entry on the list of doctoral students,
   b) a proposal to change the limit of places for a scientific discipline,
   c) establishing a reserve list,
8) preparing information for the admissions committee on the course of the qualification procedure in the case of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and the members of the selection team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairman of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the Chairman of the qualification team of any circumstances that may affect his or her impartiality and objectivity in the assessment of candidates for the Doctoral School.
3. A member of the selection team is excluded from the candidate's assessment in particular if:
   1) provided the candidate with the statement referred to in § 6 section 1 point 3,
   2) he was the supervisor of the candidate's master's thesis;
   3) is the candidate's superior or is in another employment relationship with the candidate;
   4) the candidate is or was his/her spouse or is a relative or in-law to the second degree, or remains or has been cohabiting with a member of the admissions committee;
   5) the candidate is or was a person related to a member of the committee by adoption, guardianship or guardianship;
   6) there are other objective circumstances that may give rise to justified concerns as to the impartiality and objectivity of the candidate's assessment.
4. The chairperson may exclude himself from the evaluation of a candidate in the cases referred to in paragraph 3.
5. The exclusion of a member of the qualification team from the assessment of a given candidate is recorded in the report of the selection team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 who:
   1) hold a master's degree, a master's degree in engineering or an equivalent title,
   2) have a documented knowledge of English at the level of language proficiency at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 4 – the list of documents confirming knowledge of English at least at the B2 level is included in Annex 5 to the admission rules
   3) by the date of submission of the application for admission to the Doctoral School, they will obtain a statement of a potential supervisor, from the list referred to in § 1 section 9 - the template of the statement is included in Appendix No. 2 to the recruitment rules.
2. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may be applied for admission by graduates of first-cycle studies or students who have completed the third year of long-cycle studies who meet the requirements referred to in section 1 points 2 and 3.
3. In the absence of a master's degree diploma due to waiting for its issuance, the candidate is obliged to present a certificate from the university confirming the award of a master's degree.
4. The certificate is not required for native English speakers.
5. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at B2 level.
6. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of the Polish language, i.e.:
   1) have completed a one-year preparatory course to study in Polish in units designated by the minister responsible for higher education, or
   2) have a certificate of proficiency in Polish issued by the State Commission for the Certification of Proficiency in Polish as a Foreign Language or
   3) have completed studies in Poland in a field of study conducted in Polish, or
   4) during the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.
7. If the Master's degree diploma was issued in a language other than Polish or English, the candidate shall attach a certified translation.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Online Registration of Candidates (IRK) system, uploading the electronic version of documents, payment of the recruitment fee - **1-18 August 2024,**
   2) qualification procedure - **19 August - 13 September 2024,** including:
      a) interviews - **11 – 13 September 2024,**
   3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 17 September 2024**,

4) issuance of an administrative decision on refusal of admission to the Doctoral School to candidates not qualified for entry on the list of doctoral students **– September 19-23, 2024**,
5) submission by candidates pre-qualified for entry on the list of doctoral students of the documents referred to in § 14 section 1 – **17-23 September 2024,**
6) announcement of the list of those admitted to the Doctoral School **- September 24, 2024**

2. The Admission Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2024, subject to paragraph 3
3. In the case of a large number of candidates, changes to the deadlines for the activities referred to in paragraph 1(2)(a) and (3)-(6) may be introduced until 20 August 2024.
4. The lists of candidates and accepted candidates referred to in paragraph 1 points 3 and 6 are published on the Doctoral School website.

Chapter III
Registration and submission

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) read these recruitment rules,
   2) preparation of electronic versions of the documents referred to in paragraph 4,
   3) select a potential supervisor and the proposed scope of research from the list referred to in § 1 section 9, hold an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtain a statement - the template of the statement is included in Appendix 2 to the recruitment rules.
2. Registration of candidates to the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the Doctoral School's website and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to in § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions (pdf format) of the following documents to the IRK system, subject to sections 5 and 6:
   1) application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the award of a master's degree, a master's degree in engineering or an equivalent title,
   3) a supplement to the Master's Diploma or another document confirming the course of study,
   4) declaration of the potential supervisor – according to the template included
      in Appendix No. 2 to the recruitment rules,
   5) concept of the doctoral dissertation – according to the template included in Appendix 3 to the recruitment rules,

6) signed information questionnaire with attachments - according to the template included in Appendix No. 4 to the recruitment rules,
7) a document certifying knowledge of English at the level of language proficiency at least B2 – the list of documents is included in Appendix 5 to the recruitment rules;
8) curriculum vitae (CV);
9) a signed information clause regarding the processing of personal data – according to the template included in Appendix No. 6 to the recruitment rules.

5. Candidates, beneficiaries of the "Diamond Grant" program, in addition to the documents
referred to in paragraph 4, submit a document confirming the receipt of the "Diamond Grant".
6. The candidates referred to in § 6 section 2 submit:
1) documents referred to in section 4 points 1 and 4-7,
2) a diploma confirming the award of an engineer's or bachelor's degree or a certificate of completion of the third year of long-cycle master's degree studies,
3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming the achievement of a second-degree qualification outside Polish shall additionally submit a translation of the diploma prepared by a sworn translator. To recognize a diploma as entitling to undertake education at the Doctoral School, the provisions of Articles 326 and 327 of the Act apply.
8. In the event of submission of incomplete documents in the recruitment procedure, which make it impossible to assess the candidate's fulfilment of the formal criteria referred to in § 6, the recruitment committee calls on the candidate to supplement them within 7 days from the date of delivery of the summons. Failure to comply with this obligation within the prescribed period results in the candidate's application not being considered, and thus the candidate is not allowed to participate in the qualification procedure.

Chapter IV
Application fee

§ 9

1. The amount of the recruitment fee to the Doctoral School is determined by the Rector by 31 May 2024.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **by 18 August 2024.**
3. In a particularly justified case, the candidate may, by 5 August 2024, submit an application to the Rector for exemption from the application fee to the Dean's Office of the Doctoral School. The Rector makes a decision within 7 days from the date of submitting the application.
4. In the event of refusal to exempt from the fee, the candidate is obliged to pay the application fee within 7 days of providing this information.
5. If the payment is not made within the time limit referred to in paragraph 2 or the application referred to in paragraph 3 is not submitted or the deadline referred to in paragraph 4 expires, the candidate is not subject to the qualification procedure.

6. A candidate is entitled – at his/her request – to a refund of the application fee in the case of:
   1) resign from participation in the qualification procedure before its commencement, i.e. before 19 August 2024;
   2) refusal to initiate the admission procedure in relation to a candidate due to failure to pay the recruitment fee on time;
   3) Overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by the qualification team competent for the scientific discipline chosen by the candidate and includes:
   1) analysis and assessment of the relationship between the candidate's completed Master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
   2) awarding ranking points in the following criteria:
      a) the result of completing a master's degree,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards ranking points to candidates in individual criteria on the terms set out in Appendix 1 to the recruitment rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the case of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside of Polish, the qualification team competent for the scientific discipline chosen by the candidate may request the candidate to present additional documents.
5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in section 1 point 2 letters a-c.
6. In the case of a beneficiary of the "Diamond Grant" programme, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c, regardless of the candidate's results in these criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b)-(e) is the arithmetic mean of the points awarded by individual members of the qualification team, rounded up to one decimal place, and may not be higher than the maximum value specified for a given criterion.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the end of the qualification procedure, the qualification team immediately submits to the admission committee the completed and signed documents referred to in § 3 section 11 item 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and their scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date, place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 shall be provided to the candidates by e-mail to the e-mail address indicated in the IRK system by 23 August 2024.
3. The interview can be conducted on-site or remotely using commonly available online tools. The preferred communicator is MS Teams.
4. Before the interview begins, the chairman or secretary of the selection team is obliged to verify the candidate's identity.
5. The interview consists of two parts:
    1) part one – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) Part two – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the initial topic of the doctoral dissertation,
    2) justification of the choice of topic, results of the analysis of the state of knowledge in the field of selected research topics, literature review,
    3) initial definition of the research problem (goal, research questions, hypotheses),
    4) the proposed methodology,
    5) expected results.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the selection committee may commission the qualification team to re-analyze the documents
   and the method of awarding ranking points. This does not apply to points awarded for an interview.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the following cases:
    1) meeting the formal requirements referred to in § 6 section 1,
    2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
    3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
    4) obtain a total of at least 55 ranking points, including at least 20 points from the interview.

3. Failure to meet the conditions referred to in paragraph 2 makes it impossible to enter a candidate on the ranking list of candidates even if the limit of places specified for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee draws up a report on the recruitment process, to which it attaches a document called the ranking list of candidates, containing information about candidates pre-qualified for entry on the list of doctoral students.
3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) an interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision on the basis of the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admission committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to increase the limit of places for the Doctoral School for the academic year 2024/2025.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) the candidate's name and surnames,
   2) final result – the sum of ranking points,
   3) designation whether the candidate has been pre-qualified for entry on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.
10. Any deletions and changes made to the ranking list after it has been signed should include a justification and be confirmed by the signature of the chairman of the admission committee.

Chapter VII
Admission and refusal of admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after being delivered to the Dean's Office of the Doctoral School no later than by 23 September 2024.
   1) declarations in accordance with the template set out in Appendix No. 7 to the recruitment rules,
   2) a diploma of completion of second-cycle studies, uniform master's degree studies or equivalent obtained on the basis of separate regulations or a certificate of obtaining a master's degree.

2. In special cases, the chairman of the admissions committee may set a deadline for the other candidate to submit the documents referred to in paragraph 1.
3. Failure to meet the requirements set out in paragraph 1 results in the deletion of the candidate from the list of pre-qualified students and a request from the admission committee to the Rector to issue a decision on refusal of admission to the Doctoral School.
4. Candidates who meet the conditions referred to in § 12 section 2 and have not been admitted due to the exhaustion of the limit of places specified for the scientific discipline constitute the reserve group. In the event of vacancies on the list of pre-qualified candidates for the Doctoral School for the academic year 2024/2025 in the scientific discipline chosen by the candidate, these persons may, by the decision of the Rector, be admitted to the Doctoral School in the order resulting from the number of points obtained.
5. The admissions committee immediately informs the candidate about admission in this mode. The provisions of paragraphs 1 and 2 shall apply accordingly, and the declaration referred to in paragraph 1 shall be submitted by the candidate within seven days from the date of providing information about this obligation, otherwise the qualification will expire by operation of law.

§ 15

1. Admission to the Doctoral School takes place by way of entry on the list of doctoral students.
2. Refusal of admission to the Doctoral School takes place by way of an administrative decision of the Rector at the request of the admission committee. The rector's decision may be appealed for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special Recruitment Procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School as part of a special recruitment procedure takes place as a separate competition procedure, except for the limits of places specified in § 1 section 8, the rules of which take into account these recruitment rules and the rules specified for the program, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. Common admission rules, after consultation with representatives of the competent institution or the head of the programme, project, grant or contract, are approved by the chairman of the admission committee
3. Special recruitment procedures for the Doctoral School are conducted by the recruitment committee and qualification teams referred to in § 2 section 1, subject to sections 4 and 5.

4. Meetings of the qualification teams and the recruitment committee as part of the special recruitment procedure may be attended by representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. If the activities of the Admission Committee and Qualification Teams are terminated during the special recruitment procedure, the Rector may extend their activities until the end of the procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2024/2025 only on condition that they ensure, throughout the entire period of education, full funding from doctoral programmes, projects, grants or contracts in the amount of not less than the amount of the scholarship specified in Article 209 section 4 of the Act and a possible increase in the scholarship and co-financing of the costs of using the research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.
8. The period of education referred to in paragraph 6 also includes the period of suspension of education and extension of the deadline for submitting the doctoral dissertation.
9. The condition for admission to the Doctoral School and financing of candidates referred to in paragraph 7 is an agreement specifying the conditions for the implementation, financing and settlement of funds for the financing of doctoral scholarships(s), increase in the amount of the scholarship or scholarships and social security costs incurred by MUT and, possibly, co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" programme, hereinafter referred to as "implementation recruitment", is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Higher Education and Science on the establishment of the "Implementation Doctorate" programme and the call for proposals.
2. Candidates for implementation recruitment should be recruited from among the employees of enterprises and other entities cooperating with the Military University of Technology.
3. By 15 April 2024, the admissions committee shall determine:
   1) schedule of implementation recruitment,
   2) list and templates of documents submitted by the potential supervisor and candidate at each stage of recruitment,
   3) the manner and place or form of submitting documents.

4. Induction recruitment is conducted by the recruitment committee and qualification teams in two stages:
   1) initial stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of documents, payment of the recruitment fee referred to in § 9 section 1 and 2 within the deadline specified in the schedule referred to in section 3 point 1,
   2) submission of documents by the admissions committee to the qualification team competent for the scientific discipline,
   3) Qualification procedure conducted by the qualification team in the scope of:
      a) analysis and evaluation of the topic of the doctoral dissertation submitted by the candidate and the scientific achievements of the potential supervisor,
      b) the candidate meets the formal requirements to:
         - participation in the programme referred to in paragraph 1, hereinafter referred to as the 'DW'
         - education at a doctoral school in accordance with § 6 section 1 and § 10 section 1 item 1,
      c) conducting an interview,
      d) awarding ranking points for the criteria referred to in §10 section 1 point 2,
      e) provide the admission committee with the documents referred to in section 3 point 3 together with recommendations for the recruitment committee regarding the candidate's qualifications for the DW programme.
6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in section 5 point 3 letter b, obtain a positive grade referred to in section 5 point 3 letter a and obtain a minimum of 20 points from the interview.
7. Before accepting the protocols of the qualification teams, the Selection Committee may order the Qualification Team to re-conduct the qualification procedure referred to in section 5(a), (b) and (d).
8. The admissions committee draws up a report on the course of the preliminary stage, to which it attachs, in the case of positive acceptance of the candidates, a document called a ranking list, containing information about candidates pre-qualified for entry on the list of doctoral students under the DW programme.
9. On the basis of the admission committee's report from the preliminary stage:
   1) an application is submitted to the minister responsible for higher education and science, hereinafter referred to as the "Minister", through the Integrated System of Services for Science (ZSUN/OSF), to qualify a candidate for participation in the DW programme, or
   2) in the event of failure to meet the requirements referred to in paragraph 6, the candidate receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2024/2025 under the programme.
10. The proposals referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.

11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is posted on the Doctoral School's website and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the preliminary stage and includes:
    1) submission by the candidate of the documents for this stage, specified in section 3 point 2,
    2) the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 14,
    3) preparation of the final protocol of the induction recruitment by the recruitment committee.
13. The Recruitment Committee may, at any stage of the induction recruitment, request the candidate to submit additional documents confirming the fulfillment of the requirements for participation in the DW program.
14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application to participate in the DW programme for the academic year 2024/2025.
15. If the Minister provides information on the failure to qualify the MUT application for participation in the DW programme, the Rector issues a decision on refusal to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final report of the recruitment committee, the candidate:
    1) is entered on the list of doctoral students of the Doctoral School for the academic year 2024/2025 under the DW programme, or
    2) receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2024/2025 under this programme.
17. The candidate's participation in the induction recruitment does not exclude, at their request, participation in the recruitment process for the Doctoral School for the academic year 2024/2025.

Chapter III
Other programmes, projects, grants, contracts

§ 18

1. Special recruitment procedures may also be conducted under other programmes, projects, grants or agreements.
2. Detailed rules of the procedure referred to in paragraph 1 are specified by the admissions committee, at least 14 days before the start of recruitment, taking into account the candidates' compliance with the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or agreement.
3. Qualification procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview taking into account the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions apply:
   1) Act
   2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the nostrification of higher education diplomas abroad and confirmation of completion of studies at a specific level (Journal of Laws No. item 1881),
   3) of the Act of 14 June 1960. Code of Administrative Procedure (i.e. Journal of Laws of 2023, item 775, as amended).

Appendix No. 1
to the Rules of Recruitment to the Doctoral School of the Military University of Technology
for the academic year 2024/2025

Specific rules awarding ranking points

1. Selection teams award ranking points to candidates according to the following criteria:

Criterion	Number of points Ranked	
1. Master's Degree Result	0:÷20	60 points in the case of candidates referred to in § 10 sec. 5 and 6 of the recruitment rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0:÷30	
4. The concept of the doctoral dissertation	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. Detailed rules for awarding ranking points in individual criteria:

1) Master's Degree Result

Result	Number of points Ranked
Very Good with Distinction (5W)	20
very good (5)	15
dobry plus (4+)	10
Good (4)	5
below good (under 4)	0

2) Qualifications and competences of a candidate for education at the Doctoral School in a selected scientific discipline

Specification	Number of ranking points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and attestations confirming the acquisition of qualifications needed in scientific work (postgraduate studies, courses, training, certificate of any foreign language above B2, etc.)	0 ÷ 5

3) Candidate's academic achievements

Specification	Number of ranking points
1) documented scientific publications published in the years 2017-2024, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 15 points for one monograph
b) chapter in a multi-author monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 5 points for one chapter – a total of no more than 10 points
c) scientific publication in journals from the list referred to in Article 267 section 3 of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 15 points.
e) participation in a scientific conference with the presentation of the paper and its publication in peer-reviewed post-conference materials, referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 10 points.
2) documented awards or scholarships	**0 ÷ 15 points**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one award or scholarship
b) obtaining the Rector's award or scholarship	0 ÷ 3 points
c) distinction for the best diploma thesis	0 ÷ 2 points
d) Other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 points**
1. distinction in the competition for the best student thesis as part of the activities of the Student Research Centre	0 ÷ 3 points;
2. distinction for the speech at the KNS seminar	0 ÷ 2 points
4) documented participation in research projects - based on statements of the principal investigators	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF format*
2. *If the sum of the points in the sub-criteria exceeds the maximum value for that criterion, the maximum number of points for that criterion will be awarded to you*

4) The concept of the doctoral dissertation

Specification	Number of ranking points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the topic of the dissertation and the justification of its selection, definition of the research problem, purpose, research questions, hypotheses, methodology and presentation of the current state of research in the field of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Number of ranking points
1) evaluation of the presentation of the concept of the doctoral dissertation in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) proposed methodology, d) novelty and originality of the issues raised, e) to present the state of research in the field of project and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct a scientific discussion, including coherence and clarity of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

(academic title/degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

(university/organizational unit)

STATEMENT

I declare that if you are accepted:

(name and surname of the candidate)

to the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2024/2025, I give my preliminary consent to scientific supervision and to perform the function of a supervisor within the research topic:

(research topics)

…….
(date)

……..
(signature of the potential supervisor)

Appendix No. 3
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

(name and surname of the candidate)

(scientific discipline)

The concept of the doctoral dissertation[1]

……..
legible signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, the definition of: the research problem, the goal, the research questions, the hypotheses, the methodology and the presentation of the current state of research in the field of the adopted subject matter - **max. 5000 characters without spaces,** Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of recruitment to the Doctoral School of the Military University of Technology
for the academic year 2024/2025.

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. BASIC DATA

1. Completed second-cycle (master's) studies

1)	Name of the university	
2)	field of study	
3)	Completion Score	
4)	year of completion	
5)	Title of the diploma thesis	
6)	name and surname of the head of the diploma thesis	

2nd Do you have a PhD degree? If <u>so</u>, please attach a copy of your doctoral diploma or provisional certificate – *<u>attachment no. 1</u>*

3rd Have you had or are you initiating doctoral proceedings or proceedings for awarding a doctoral degree? If so, please provide the university/institute and scientific discipline and the topic of the dissertation.

4th Have you been or are you a participant of doctoral studies (third-cycle studies)? If <u>so</u> , please provide the university/institute, scientific discipline, year of commencement - year of completion

5th Have you been or are you a doctoral student at a doctoral school? If <u>so</u> , please provide the name of the doctoral school, scientific discipline, date of beginning and end of education

6. Current employment

(name of the workplace, city, position held, status – professional soldier, police officer, prison service officer, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1st Trips abroad and individual studies:

1) **mobility under programs, e.g. Erasmus** – ***Annex 2***

(name of the programme, date of departure, semester of study, host university, country)

2) **Foreign internships** – ***Appendix No. 3***

(name of the traineeship, date, semester of study, host institution, country)

3) **Individual studies - *Appendix No. 4***

(semester(s) of study, level of study)

2nd Certificates and attestations confirming the acquisition of qualifications necessary for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3rd Document certifying knowledge of a foreign language at the level of language proficiency above B2 - *Appendix No. 6*[1]

(name of certificate/attestation)

4th Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Appendix No. 7*[2]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1st Publishing activities in the years 2017 - 2024[3]:

1) monograph from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 8***

(author(s), title, publisher, year of publication, number of points)

[1] documents confirming knowledge of any foreign language at the level above B2, e.g. C1, C2, above SPJ 3333

[2] documents referred to in § 6 section 6 points 1-3

[3] in the case of:

- the monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, a title page and an abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

2) chapter in a multi-author monograph, from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 9***

(author(s), title, title of the monograph, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267 (3) of the Act - ***Appendix No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267 section 3 of the Act - ***Appendix No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication
in peer-reviewed post-conference materials, in the list referred to in Article 267 (3) of the Act - ***Appendix No. 12***

(name of the conference, date, place, topic of the presentation, author(s)

2. Awards, scholarships obtained

1) awards or scholarships of the minister responsible for higher education and science or the Minister of National Defence – ***Appendix 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***Appendix No. 14***

(name of the award or scholarship, date of award)

3) Distinction for the best diploma thesis – ***attachment no. 15***

(bachelor's/master's thesis, date of award)

4) Other awards for research activity – ***Appendix 16***

(title of the award, date of award)

3rd Achievements in the Students' Scientific Club (KNS)

1) distinction in the competition for the best student thesis as part of the activities of the Committee – ***Appendix No. 17***

(topic of the thesis, date of award)

2) distinction for the presentation at the SCS seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4th Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from- to	University, scientific institution where the project is implemented	Academic title/degree name and surname Manager Project	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the appendix to the point/subsection of the Questionnaire should contain confirmation of all information indicated in this point/subsection,
- attachments should contain confirmations of awards, scholarships, distinctions in the form of scans of diplomas, certificates, decisions,
- Confirmation of the candidate's participation in research projects is a certificate from the principal investigator, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, date	*signature of the candidate*

Appendix No. 5
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

List
documents confirming knowledge of English
at least B2 level

In the recruitment procedure to the Doctoral School of MUT, the candidate's documents confirming his/her knowledge of English at least at the B2 level on the global scale of language proficiency according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)" are accepted:

1. Diplomas with a graphic sign indicating level 6 or 7. The Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language taught during the studies was English and the learning outcomes were achieved for English.
2. Information in the supplement to the diploma of graduation that you have passed the English language exam at least at B2 level.
3. Diplomas in English Philology.
4. Certificate confirming the knowledge of a foreign language issued by the National School of Public Administration as a result of a linguistic verification procedure.
5. Certificates confirming the achievement of at least the level of SPJ 3333 in English according to the NATO Standardization Agreement STANAG 6001.
6. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
7. A document issued abroad recognized as equivalent to a secondary school-leaving certificate if the language of instruction was English.
8. International Baccalaureate Diploma or European Baccalaureate Diploma.
9. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
10. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the qualifications of a sworn translator in another Member State of the European Union, a member state of the European Free Trade Association (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
11. Certyfikaty odpowiadające poziomowi co najmniej B2 wydane przez instytucje stowarzyszone w Association of Language Testers in Europe (ALTE) oraz Educational Testing Service (ETS), European Consortium for the Certificate of Attainment in Modern Languages (ECL); City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute, Edexcel, Pearson

Language Tests, Pearson Language Assessments; Education Development International (EDI), London Chamber of Commerce and Industry Examinations Board; University of Cambridge ESOL Examinations, British Council, IDP IELTS Australia; telc GmbH, WBT Weiterbildungs-Testsysteme GmbH; uczelnie zrzeszone w Stowarzyszeniu Akademickich Ośrodków Nauczania Języków Obcych SERMO.

12. Other certificates, attestations, diplomas not listed above – if they are approved by the Head of the Foreign Language Centre of the Military University of Technology.

Appendix No. 6
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

Information clause

Pursuant to Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Jarosław Dąbrowski Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of personal data processing, who can be contacted via the following e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for recruitment purposes to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes, as well as for the purpose of pursuing and defending against possible claims.
4. The data provided will be processed on the basis of Article 6(1)(c) and (e) of the GDPR, i.e. in order to comply with a legal obligation to which the Controller is subject and when the processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the Controller.
5. In the case of awarding an increased scholarship amount, data of special categories in the form of a person's health condition (including disability) will be processed on the basis of Article 9(2)(b), i.e. the processing is necessary for the fulfilment of duties and performance by the Administrator in the field of labour law, social security and social protection.
6. Providing data is voluntary, but necessary to achieve the purposes for which it was collected. Failure to provide them will make it impossible to conduct recruitment and admission to the first year of education at the Doctoral School.
7. Personal data will not be made available to other recipients, except for the minister competent for higher education and science, the Minister of National Defence and cases provided for by law.
8. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
9. You have the right to access your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
10. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
11. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the

President of the Office for Personal Data Protection, if they believe that the processing of personal data violates the generally applicable regulations in this respect.

I confirm that I have read and acknowledge the above information.

....

city, date legible signature of the candidate

Appendix No. 7
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2024/2025

……....., on .....

……
Candidate's name

……
scientific discipline

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **October 1, 2024.**:

1. The Doctoral School of the Jarosław Dąbrowski Military University of Technology will be the only doctoral school where I will carry out education;
2. I have/do not have* a doctoral degree[1];
3. I have/do not have* the certificate(s):[2]
   1) on disability*,
   2) on the degree of disability* referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2021, item 573, as amended).

……..
legible signature of the candidate

Attachments:

1. ……
2. ……

**- delete as appropriate*

[1] in the case of holding a doctoral degree, a copy of the diploma on awarding the doctoral degree or a provisional certificate should be attached
[2] If you have a certificate, you must attach a copy of it

Wojskowa Akademia Techniczna

Resolution
of the Senate of the Military University of Technology

No. 8/WAT/2025 of 27 February 2025

on the determination of the "Rules of recruitment"
to the Doctoral School of the Military University of Technology
for the academic year 2025/2026

Pursuant to Article 200(2) of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2024, item 1571, as amended), in connection with § 21 section 1 point 27 of the Statute of the Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), it is hereby resolved, as follows:

§ 1

The "Rules of recruitment" to the Doctoral School of the Military University of Technology for the academic year 2025/2026" *are hereby established,* constituting an attachment to the resolution.

§ 2

The resolution shall enter into force on the date of its adoption.

President of the Senate

gen. bryg. prof. dr hab. inż. Przemysław Wachulak

Attachment
to Resolution No. 8/WAT/2025 of the Senate of the Military University of Technology
of 27 February 2025 r.

Recruitment rules
to the Doctoral School of the Military University of Technology for the academic year 2025/2026

Section I
General

§ 1

1. The Doctoral School of the University of Technology, referred as the "Doctoral School", is recruiting persons hereinafter referred to as "candidates" for the academic year 2025/2026 in the following scientific disciplines:
   1) automation, electronics, electrical engineering and space technologies,
   2) information and telecommunication technology,
   3) civil engineering, geodesy and transport,
   4) materials engineering,
   5) mechanical engineering,
   6) security studies,
   7) chemical sciences.
2. The purpose of the recruitment procedure is to select the best candidates for education at the Doctoral School.
3. Recruitment to the Doctoral School takes place through a competition in accordance with these Recruitment Rules for the Doctoral School of the Military University of Technology for the academic year 2025/2026, hereinafter referred to as the "Recruitment Rules".
4. In the case of recruitment to the Doctoral School in scientific disciplines within which education will be carried out in English, the recruitment procedure is conducted in English.
5. Recruitment of foreigners to the Doctoral School is carried out on the same terms as for Polish citizens, considering the provisions of the Act of 20 July 2018 – Law on Higher Education and Science (i.e. Journal of Laws of 2024, item 1571, as amended), hereinafter referred to as the "Act".
6. The rules and procedure for sending professional soldiers to the Doctoral School in the service mode are regulated by the provisions of the Act of 11 March 2022 on the Defence of the Homeland (i.e. Journal of Laws of 2024, item 248, as amended).
7. Candidates with disabilities are subject to the same recruitment rules as other candidates applying for admission to the Doctoral School.
8. The limit of places in the Doctoral School is determined by the Rector by 30 May 2025, at the request of the director of the Doctoral School, hereinafter referred to as the "director".
9. By 30 May 2025, the Councils of Scientific Disciplines will establish lists of potential supervisors along with the thematic scope of the research.
10. The Councils for Scientific Disciplines may amend the lists referred to in paragraph 9 by 31 July 2025.
11. The resolutions referred to in paragraphs 9 and 10 shall be immediately forwarded by the Chairman of the Scientific Discipline Council to the Director.

Section II
Selection committee and selection teams

§ 2

1. To conduct the recruitment procedure to the Doctoral School, at the request of the Director, the Rector appoints by way of a decision:
   1) the Admission Committee of the Doctoral School, hereinafter referred to as the "Admission Committee",
   2) at least one Qualification Team for each scientific discipline referred to in § 1 section 1, hereinafter referred to as the "Qualification Team".
2. The admissions committee and qualification teams are appointed by the Rector for the period from 15 April 2025 to 14 April 2026.
3. At the request of the chairperson of the admissions committee or the chairman of the qualification team, the Rector may appoint new members or dismiss the appointed members of the admissions committee or the qualification team, respectively.
4. Work in the recruitment committee and in the qualification, team is remunerated. In the decision referred to in paragraph 1, the Rector lays down the rules for awarding remuneration, the amount of which is specified in the Remuneration Regulations.

§ 3

1. The admissions committee consists of:
   1) chairman – the director;
   2) one representative of the scientific discipline referred to in § 1 section 1,
   3) other persons nominated by the head,
   4) secretary – head of the Dean's Office of the Doctoral School.
2. By 21 March 2025, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 item 1 shall provide the director with the data of the representatives referred to in paragraph 1 item 2, selected from among academic teachers holding the academic title of professor or the academic degree of habilitated doctor conducting scientific or didactic activity within the scope of this scientific discipline.
3. A representative appointed by the Doctoral Students' Government may participate in the deliberations of the Admission Committee as an observer.
4. Administrative support for the recruitment committee is provided by the Dean's Office of the Doctoral School.
5. The chairman of the admissions committee convenes meetings of the admissions committee and chairs its meetings.
6. Committee meetings may be held remotely. Decisions on the form of the meeting are made by the chairman of the admissions committee.
7. Meetings of the admissions committee are recorded. The minutes are signed by the chairman of the admissions committee and the members of the committee participating in the meeting, subject to paragraph 9.
8. In the case of a committee meeting conducted remotely, the minutes are signed only by the chairman of the admission committee.
9. In the absence of the chairman, the committee meeting is convened and chaired by a committee member authorized by the chairman.
10. Tasks of the admissions committee:
    1) supervision over the recruitment and qualification procedure,

2) analysis of the correctness and completeness of documents submitted by candidates,
3) preparation and submission to qualification teams:
    a) candidates' documents,
    b) the template of the protocol,
    c) individual assessment cards of the candidate,
4) setting the dates of interviews within individual scientific disciplines,
5) setting individual dates for interviews and notifying candidates,
6) determining, based on the protocols of the qualification teams, ranking lists in individual scientific disciplines and the list of persons pre-qualified for entry on the list of doctoral students,
7) publication on the Doctoral School's website of the list of pre-qualified persons and, after verification of the documents referred to in § 14 section 1, the list of persons admitted to the Doctoral School within individual scientific disciplines,
8) preparation of a decision on refusal of admission to the Doctoral School.

§ 4

1. The qualification team for a scientific discipline includes:
    1) chairman
    2) two members at least,
    3) secretary.
2. By 21 March 2025, the chairpersons of the Councils for Scientific Disciplines referred to in § 1 section 1 shall submit to the director the data of candidates for:
    1) the chairperson and members of the team – from among academic teachers holding the academic title of professor or the academic degree of doctor “habilitowany” conducting scientific or didactic activity in the field of this scientific discipline,
    2) secretary - from among the employees of the faculty related to the scientific discipline appropriate for the Council.
3. Tasks of the qualification teams:
    1) analysis of candidates' documents submitted by the recruitment committee,
    2) analysis and assessment of the relationship between the candidate's completed master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
    3) analysis of qualifications and competences as well as scientific achievements of candidates and awarding ranking points in accordance with point 2 subsections 1-3 of Appendix No. 1 to the recruitment rules,
    4) analysis of the concept of the doctoral dissertation of the candidates and awarding ranking points in accordance with point 2 subsection 4 of Annex 1 to the recruitment rules,
    5) conducting an interview and awarding ranking points in accordance with point 2 subsection 5 of Appendix No. 1 to the recruitment rules.
    6) determining the general, total number of ranking points obtained by the candidate from all the criteria referred to in point 1 of Appendix No. 1 to the recruitment rules,
    7) Submission of the protocol to the Recruitment Committee along with individual evaluation sheets of candidates and recommendations to the Recruitment Committee on:

a) pre-qualification of candidates for entry on the list of doctoral students,
b) a proposal to change the limit of places for a scientific discipline,
c) establishing a reserve list of candidates,

8) preparing information for the admissions committee on the course of the qualification procedure in the case of a candidate's request for reconsideration of the case.

4. Meetings of the qualification team are recorded. The minutes shall be signed by the chairman and the members of the selection team participating in the meeting, subject to paragraph 5.
5. In the case of a meeting conducted remotely, the minutes are signed only by the chairman of the qualification team.

§ 5

1. A member of the qualification team is obliged to maintain impartiality and objectivity in the assessment of candidates for the Doctoral School.
2. A member of the qualification team informs the chairman of the qualification team of any circumstances that may affect his or her impartiality and objectivity in the assessment of candidates for the Doctoral School.
3. A member of the selection team is excluded from the candidate's assessment in particular if:
   1) provided the candidate with the statement referred to §6 section 1 point 3,
   2) he was the supervisor of the candidate's master's thesis;
   3) is the candidate's superior or is in another employment relationship with the candidate;
   4) the candidate is or was his/her spouse or is a relative or in-law to the second degree, or remains or has been cohabiting with a member of the admissions committee;
   5) the candidate is or was a person related to a member of the committee by adoption;
   6) there are other objective circumstances that may give rise to justified concerns as to the impartiality and objectivity of the candidate's assessment.
4. The chairperson may exclude himself from the evaluation of a candidate in the cases referred to in paragraph 3.
5. If at least two members of the qualification team are excluded from the candidate's evaluation, the chairperson applies to the Rector to appoint new members of the team.
6. The exclusion of a member of the qualification team from the assessment of a given candidate is recorded in the report of the selection team.

Section III
Recruitment procedure

Chapter I
Formal criteria

§ 6

1. Candidates may apply for admission to the Doctoral School in the scientific discipline specified in § 1 section 1 who:
   1) hold a master's degree, a master's degree in engineering or an equivalent title,
   2) have a documented knowledge of English at a level of language proficiency of at least B2 according to the Common European Framework of Reference for Languages (CEFR), subject to paragraph 5 – the template of the declaration is included in Annex 8 to the admission rules,
   3) obtain a statement from a potential supervisor from the list referred to in § 1 section 9 - the template of the statement is included in Appendix No. 2 to the recruitment rules.
2. In exceptional cases, justified by the highest quality of scientific achievements, the Doctoral School may be applied for admission by graduates of first-cycle studies or students who have completed the third year of long-cycle studies who meet the requirements referred to in section 1 points 2 and 3.
3. Confirmation of English language proficiency at least B2 level are only the documents indicated in Appendix No. 5 to the recruitment rules.
4. In the absence of a master's degree diploma due to waiting for its issuance, the candidate is obliged to present a certificate from the university confirming the award of a master's degree.
5. The certificate is not required for native English speakers.
6. Candidates may undertake education at the Doctoral School conducted in English if they have knowledge of English at least at B2 level.
7. Foreigners may undertake education at the Doctoral School conducted in Polish if, in addition to knowledge of English at the B2 level, they demonstrate knowledge of the Polish language, i.e.:
   1) have completed a one-year preparatory course to study in Polish in units designated by the minister responsible for higher education, or
   2) have a certificate of proficiency in Polish issued by the State Commission for the Certification of Proficiency in Polish as a Foreign Language or
   3) have completed studies in Poland in a field of study conducted in Polish, or
   4) during the interview, they will receive confirmation that their preparation and level of knowledge of the Polish language allow them to undertake education in Polish.
8. If the Master's degree diploma was issued in a language other than Polish or English, the candidate shall attach a certified translation into Polish.

Chapter II
Schedule of the recruitment procedure

§ 7

1. The schedule of the recruitment procedure includes:
   1) registration of the candidate in the Online Registration of Candidates (IRK) system, completion of forms, uploading electronic versions of documents, payment of the recruitment fee - **1-17 August 2025,**
   2) Admission procedure - **18 August - 12 September 2025,** including interviews with candidates within the following scientific disciplines:
      - Automation, electronics, electrical engineering and space technologies - **10-11 September 2025**,
      - Technical informatics and telecommunications – **September 8-9, 2025**;
      - Civil engineering, geodesy and transport - **10 September 2025**;
      - Materials engineering - **September 11, 2025**;
      - Mechanical engineering - **September 10-12, 2025**;
      - Security sciences - **September 10-12, 2025**;
      - Chemical sciences - **September 12, 2025**
   3) announcement of the list of candidates pre-qualified for inclusion on the list of doctoral students **– 17 September 2025**,
   4) issuance of an administrative decision on refusal of admission to the Doctoral School to candidates not qualified for entry on the list of doctoral students **– 23-25 September 2025**,
   5) submission by candidates pre-qualified for entry on the list of doctoral students of the documents referred to in § 14 section 1 – **17-23 September 2025,**
   6) announcement of the list of those admitted to the Doctoral School **- September 25, 2025**
2. The Admission Committee may make changes to the schedule referred to in paragraph 1 by providing information on this matter on the Doctoral School's website by 15 July 2025, subject to paragraph 3
3. In the case of to many candidates, changes to the deadlines for the activities referred to in paragraph 1(2)-(6) may be introduced until 20 August 2025.
4. The lists referred to in section 1 points 3 and 6 are published on the Doctoral School's website.

Chapter III
Registration and submission

§ 8

1. Before registering in the IRK system, the candidate is obliged to:
   1) read these recruitment rules,
   2) preparation of electronic versions of the documents referred to paragraph 4,
   3) select a potential supervisor and the proposed scope of research from the list referred to § 1 section 9, hold an initial interview with the potential supervisor about the possibility of scientific supervision and research topics, and obtain his/her signature on the statement - a template of the statement is included in Appendix 2 to the recruitment rules.

2. Registration of candidates to the Doctoral School and submission of documents takes place only electronically via the IRK in accordance with the instructions available on the Doctoral School's website and in the IRK system.
3. A candidate may register and choose only one scientific discipline from among the disciplines referred to § 1 section 1.
4. After registering in the IRK system (creating an account) and filling in the forms, the candidate uploads electronic versions of the following documents (pdf format) to the IRK system, subject to sections 5 and 6:
   1) application for admission to the Doctoral School generated from the IRK system and signed,
   2) a diploma confirming the award of a master's degree, a master's degree in engineering or an equivalent title,
   3) a supplement to the Master's Diploma or another document confirming the course of study,
   4) declaration of the potential supervisor – according to the template included in Appendix 2 to the recruitment rules,
   5) concept of the doctoral dissertation – according to the template included in Appendix 3 to the recruitment rules,
   6) information questionnaire with attachments - according to the template included in Appendix 4 to the recruitment rules,
   7) a declaration of English language proficiency at least B2 – according to the template included in Appendix 8 to the recruitment rules,
   8) curriculum vitae (CV),
   9) a signed information clause regarding the processing of personal data – according to the template included in Appendix No. 6 to the recruitment rules.
5. Candidates, beneficiaries of the "Diamond Grant" program, in addition to the documents
   referred to in paragraph 4, submit a document confirming the receipt of the "Diamond Grant".
6. The candidates referred to in § 6 section 2 submit:
   1) documents referred to in section 4 points 1 and 4-9,
   2) a diploma confirming the award of an engineer's or bachelor's degree or a certificate of completion of the third year of long-cycle master's degree studies,
   3) documents confirming the highest quality scientific achievements.
7. A candidate holding a diploma confirming the award of a second-degree qualification outside Polish shall additionally submit a translation of the diploma prepared by a sworn translator, subject to § 6 section 7. To recognize a diploma as entitling to undertake education at the Doctoral School, the provisions of Articles 326 and 327 of the Act apply.
8. If the documents referred to in paragraph 4 are not submitted, the admission committee calls the candidate to complete them within 7 days from the date of sending the request to the candidate's e-mail address indicated in the IRK system. Failure to complete the documents within the set deadline will result in the candidate's not being admitted to the qualification procedure.

Chapter IV
Application fee

§ 9

1. The amount of the recruitment fee to the Doctoral School is determined by the Rector by 30 May 2025.
2. The candidate makes a payment to the individual bank account generated for each candidate by the IRK system, no later than **by 18 August 2025.**
3. In a particularly justified case, the candidate may, by 5 August 2025, submit an application to the Dean's Office of the Doctoral School to the Rector for exemption from the application fee. The Rector makes a decision within 7 days from the date of submitting the application.
4. In the event of refusal to exempt from the fee, the candidate is obliged to pay the application fee within 7 days of providing this information.
5. If the payment is not made within the time limit referred to in paragraph 2 or the application referred to in paragraph 3 is not submitted or the deadline referred to in paragraph 4 expires, the candidate is not subject to the qualification procedure.
6. A candidate is entitled – at his/her request – to a refund of the application fee in the case of:
   1) resignation from participation in the qualification procedure before its commencement, i.e. before 18 August 2025,
   2) overpayment.

Chapter V
Qualification procedure

§ 10

1. The qualification procedure is conducted by the qualification team competent for the scientific discipline chosen by the candidate and includes:
   1) analysis and assessment of the relationship between the candidate's completed Master's degree programme, other forms of education and scientific achievements, and the scientific discipline chosen by him/her,
   2) awarding ranking points in the following criteria:
      a) the result of completing a master's degree,
      b) qualifications and competences for education at the Doctoral School,
      c) scientific achievements,
      d) concept of the doctoral dissertation,
      e) interview.
2. The qualification team awards ranking points to candidates in individual criteria on the terms set out in Appendix 1 to the recruitment rules.
3. The qualification team, to the extent referred to in paragraph 1 point 1, recommends a positive or negative assessment to the qualification committee. In the case of a negative assessment, the Qualification Team prepares a justification.
4. In the case of a person holding a diploma of studies completed outside of Polish, the qualification team competent for the scientific discipline chosen by the candidate may request the candidate to present additional documents.

5. In the case of a positive assessment of the candidates referred to in § 6 section 2, the qualification team awards the candidate 60 points for the criteria referred to in section 1 point 2 letters a-c.
6. In the case of a beneficiary of the "Diamond Grant" programme, the qualification team awards the candidate 60 points for the criteria referred to in paragraph 1 point 2 letters a-c, regardless of the candidate's results in these criteria.
7. The number of ranking points of the candidate for the criterion referred to in paragraph 1(2)(b)-(e) is the arithmetic mean of the points awarded by individual members of the qualification team, rounded up to one decimal place, and may not be higher than the maximum value specified for a given criterion.
8. The maximum number of ranking points that can be awarded by the qualifying team from the criteria referred to in paragraph 1 point 2 is 110 points.
9. After the end of the qualification procedure, the qualification team immediately submits to the admission committee the completed and signed documents referred to in § 3 section 10 item 2.

§ 11

1. The purpose of the interview is to check the candidate's preparation and motivation to conduct scientific work and their scientific interests based on the presented research project and general knowledge of the scientific discipline.
2. Information on the date, place or form of the interview for candidates within the scientific discipline referred to in § 1 section 1 shall be provided to the candidates by e-mail to the e-mail address indicated in the IRK system by 29 August 2025.
3. The interview can be conducted on-site or remotely using commonly available online tools. The preferred communicator is MS Teams.
4. Before the interview begins, the chairman or secretary of the selection team is obliged to verify the candidate's identity.
5. The interview consists of two parts:
    1) part one – presentation by the candidate of the initial concept of the doctoral dissertation prepared in accordance with the research topic agreed with the potential supervisor – max. 15 min.,
    2) Part two – questions from the members of the qualification team aimed at checking the ability to justify/defend the presented concept of the doctoral dissertation, conduct a scientific discussion and motivation for research work, as well as the candidate's general knowledge in the field of the selected scientific discipline.
6. The candidate's presentation should include the following issues:
    1) the initial topic of the doctoral dissertation,
    2) justification of the choice of topic, results of the analysis of the state of knowledge in the field of selected research topics, literature review,
    3) initial definition of the research problem (aim, research questions, hypotheses, subject of the dissertation),
    4) the proposed methodology,
    5) expected results.

Chapter VI
Results of the recruitment procedure

§ 12

1. Before accepting the protocols of the qualification teams, the selection committee may commission the qualification team to analyse the documents and the method of awarding ranking points.
2. A candidate may be considered within the limit of places for a scientific discipline to be entered on the list of doctoral students only in the following cases:
   1) meeting the formal requirements referred to in § 6 section 1,
   2) payment of the recruitment fee, in accordance with the conditions specified in § 9,
   3) obtaining a positive assessment referred to in § 10 section 1 point 1 and section 3,
   4) obtain a total of at least 55 ranking points, including at least 20 points from the interview.
3. Failure to meet the conditions referred to in paragraph 2 makes it impossible to enter a candidate on the ranking list of candidates even if the limit of places specified for the scientific discipline is not used.

§ 13

1. The results of the recruitment procedure are public.
2. The admissions committee draws up a report on the recruitment process, to which it attaches a document called the ranking list of candidates, containing information about candidates pre-qualified for entry on the list of doctoral students.
3. The order in which candidates are placed on the ranking list is determined by the number of ranking points and the fulfilment of the requirements referred to in § 12 section 2.
4. If candidates obtain the same total number of ranking points, admission to the Doctoral School is determined by the number of points awarded in the first place for:
   1) an interview referred to in § 10 section 1 point 2 letter e,
   2) scientific achievements referred to in § 10 section 1 point 2 letter c.
5. In the absence of a decision based on the conditions referred to in paragraph 4, the decision on admission to the Doctoral School is made by the admission committee.
6. After analysing the preliminary results of the recruitment procedure, the Admission Committee may apply to the Rector to change the limit of places for individual scientific disciplines or to increase the limit of places for the Doctoral School for the academic year 2025/2026.
7. Candidates who do not meet the conditions referred to in § 12 section 2 are placed on the ranking list in a separate group below the candidates who meet these conditions.
8. The ranking list includes:
   1) the candidate's name and surnames,
   2) final result – the sum of ranking points,
   3) designation whether the candidate has been pre-qualified for entry on the list of doctoral students of the Doctoral School.
9. The ranking list is signed by the chairman of the recruitment committee.

10. Any deletions and changes made to the ranking list after it has been signed should include a justification and be confirmed by the signature of the chairman of the admission committee.

Chapter VII
Admission and refusal of admission to the Doctoral School

§ 14

1. A candidate pre-qualified for entry on the list of doctoral students is admitted to the Doctoral School after being delivered to the Dean's Office of the Doctoral School no later than by 23 September 2025.
   1) declarations in accordance with the template set out in Appendix No. 7 to the recruitment rules,
   2) a diploma of completion of second-cycle studies, uniform master's degree studies or equivalent obtained on the basis of separate regulations or a certificate of obtaining a master's degree.
2. In special cases, the chairman of the admissions committee may set a deadline for the other candidate to submit the documents referred to in paragraph 1.
3. Failure to meet the requirements set out in paragraph 1 results in the deletion of the candidate from the list of those pre-qualified for entry on the list of doctoral students and a request from the admission committee to the Rector to issue a decision on refusal of admission to the Doctoral School.
4. Candidates who meet the conditions referred to in § 12 section 2 and have not been admitted due to the exhaustion of the limit of places specified for the scientific discipline constitute the reserve group. In the event of vacancies on the list of pre-qualified candidates for the Doctoral School for the academic year 2025/2026 in the scientific discipline chosen by the candidate, these persons may, by the decision of the Rector, be admitted to the Doctoral School in the order resulting from the number of points obtained.
5. The admissions committee immediately informs the candidate about admission in this mode. The provisions of paragraphs 1 and 2 shall apply accordingly, and the declaration referred to in paragraph 1 shall be submitted by the candidate within seven days from the date of providing information about this obligation, otherwise the qualification will expire by operation of law.

§ 15

1. Admission to the Doctoral School takes place by way of entry on the list of doctoral students.
2. Refusal of admission to the Doctoral School is made by way of an administrative decision of the Rector at the request of the admission committee. The Rector's decision may be appealed for reconsideration of the case within 14 days from the date of its delivery.

Section IV
Special recruitment procedures

Chapter I
General

§ 16

1. Recruitment of candidates to the Doctoral School as part of a special recruitment procedure takes place as a separate competition procedure, except for the limits of places specified in § 1 section 8, the rules of which consider these recruitment rules and the rules specified for the program, project, grant or agreement, hereinafter referred to as the "common recruitment rules".
2. Common admission rules, after consultation with representatives of the competent institution or the head of the programme, project, grant or contract, are approved by the chairman of the admission committee
3. The special recruitment procedure for the Doctoral School is conducted by the admission committee and the qualification teams referred to in § 2 section 1, subject to sections 4 and 5.
4. Meetings of the qualification teams and the recruitment committee as part of the special recruitment procedure may be attended by representatives or managers referred to in paragraph 2.
5. The Chairman of the Recruitment Committee, at the request of the persons referred to in paragraph 2, may appoint additional qualification teams.
6. Special recruitment procedures can be conducted throughout the year. In the event of termination of the activity of the Admission Committee and qualification teams during the special recruitment procedure, the Rector may extend their activity until the end of the procedure.
7. Candidates recruited under a special recruitment procedure may be admitted to the Doctoral School for the academic year 2025/2026 only if they ensure, throughout the entire period of education, full funding from doctoral programmes, projects, grants or contracts in the amount not lower than the amount of the scholarship specified in Article 209 section 4 of the Act and a possible increase in the scholarship and co-financing of the costs of using the research infrastructure, as well as financing activities related to the procedure for awarding a doctoral degree.
8. The period of education referred to in paragraph 7 also includes the period of suspension of education and extension of the deadline for submitting the doctoral dissertation.
9. The condition for admission to the Doctoral School and financing of candidates referred to in paragraph 7 is an agreement specifying the conditions for the implementation, financing and settlement of funds for the financing of doctoral scholarships(s), increase in the amount of the scholarship or scholarships and social security costs incurred by MUT and, possibly, co-financing of the costs of using research infrastructure, as well as financing activities related to the procedure for the award of a doctoral degree.

Chapter II
"Implementation Doctorate" program

§ 17

1. Recruitment of candidates to the Doctoral School under the "Implementation Doctorate" program, hereinafter referred to as the "DW Program" is conducted as a special recruitment procedure on the basis of the Communication of the Minister of Science on the establishment of the "Implementation Doctorate" program and the call for applications.
2. Candidates for the DW programme should be recruited from among the employees of companies and other entities cooperating with the Military University of Technology.
3. The Recruitment Committee, after publishing the Communication referred to in paragraph 1, determines:
   1) recruitment schedule,
   2) list and templates of documents submitted by the potential supervisor and candidate at each stage of recruitment,
   3) the manner and place or form of submitting documents.
4. Recruitment for the DW program is conducted by the admissions committee and qualification teams in two stages:
   1) initial stage,
   2) final stage.
5. The initial stage includes:
   1) registration of the candidate in the IRK system, uploading the electronic version of the documents, payment of the recruitment fee referred to in § 9 section 1 to an individual bank account generated for each candidate by the IRK system within the deadline specified in the schedule referred to in section 3 item 1,
   2) submission of documents by the admissions committee to the qualification team competent for the scientific discipline,
   3) Qualification procedure conducted by the qualification team in the scope of:
      a) analysis and evaluation of the topic of the doctoral dissertation submitted by the candidate and the scientific achievements of the potential supervisor,
      b) the candidate meets the formal requirements to:
         - participation in the DW program,
         - education at the Doctoral School of the Military University of Technology in accordance with § 6 section 1 and § 10 section 1 point 1,
      c) conducting an interview,
      d) awarding ranking points for the criteria referred to §10 section 1 point 2,
      e) provide the admission committee with the documents referred to section 3 point 3 together with recommendations for the recruitment committee regarding the candidate's qualifications for the DW programme.
6. A candidate may obtain a positive recommendation from the qualification team only if they meet the formal requirements referred to in section 5 point 3 letter b, obtain a positive grade referred to in section 5 point 3 letter a and obtain a minimum of 20 points from the interview.

7. Before accepting the protocols of the qualification teams, the Selection Committee may order the Selection Team to re-conduct the qualification procedure referred to in section 5(3)(a), (b) and (d).
8. The admissions committee draws up a report on the course of the preliminary stage, to which it attachs, in the case of positive acceptance of the candidates, a document called a ranking list, containing information about candidates pre-qualified for entry on the list of doctoral students under the DW programme.
9. On the basis of the admission committee's report from the preliminary stage:
   1) an application is submitted to the Minister of Science to qualify a candidate for participation in the DW programme through the Integrated System of Services for Science (ZSUN/OSF), or
   2) in the event of failure to meet the requirements referred to in paragraph 6, the candidate receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2025/2026 under the programme.
10. The proposals referred to in paragraph 9(1) shall be prepared separately for each pre-qualified candidate.
11. The results of the preliminary stage are public. Information about the candidate's qualification or non-qualification is posted on the Doctoral School's website and sent to the candidate's e-mail address.
12. The final stage applies only to candidates who have been entered on the ranking list in the preliminary stage and includes:
   1) submission by the candidate of the documents for this stage, specified in section 3 point 2,
   2) the final qualification of candidates from the ranking list by the recruitment committee, subject to paragraph 14,
   3) preparation by the recruitment committee of the final report on recruitment to the DW program.
13. The admissions committee may, at any stage of the recruitment process for the DW program, request the candidate to submit additional documents confirming the fulfilment of the requirements for participation in the DW program.
14. The final qualification is carried out only if the Minister provides information on the qualification of the candidate's application to participate in the DW programme for the academic year 2025/2026.
15. If the Minister provides information on the failure to qualify the MUT application for participation in the DW programme, the Rector issues a decision on refusal to admit the candidate to the Doctoral School under this programme, regardless of the results of the initial stage.
16. As a result of the final qualification, on the basis of the final report of the recruitment committee, the candidate:
   1) is entered on the list of doctoral students of the Doctoral School for the academic year 2025/2026 under the DW programme, or
   2) receives the Rector's decision on refusal of admission to the Doctoral School for the academic year 2025/2026 under this programme.
17. The candidate's participation in the recruitment process for the DW programme does not exclude, at his/her request, participation in the recruitment process for the Doctoral School for the academic year 2025/2026.

Chapter III
Other programmes, projects, grants, contracts

§ 18

1. Special recruitment procedures may also be conducted under other programmes, projects, grants or agreements.
2. Detailed rules of the procedure referred to in paragraph 1 are specified by the admissions committee, at least 14 days before the start of recruitment, considering the candidates' compliance with the formal requirements referred to in § 6 section 1 and the requirements specified for the programme, project, grant or agreement.
3. Qualification procedures carried out as part of the procedures referred to in paragraph 1 should be based on an interview considering the additional requirements of the project/programme, grant or contract.

Section V
Final provisions

§ 19

1. In matters not regulated by these rules, the following provisions apply:
   1) Act
   2) Regulation of the Minister of Science and Higher Education of 28 September 2018 on the nostrification of higher education diplomas abroad and confirmation of completion of studies at a specific level (Journal of Laws No. item 1881),
   3) of the Act of 14 June 1960. The Code of Administrative Procedure (i.e. Journal of Laws of 2024, item 572, as amended).

Appendix No. 1
to the Rules of Recruitment to the Doctoral School of the Military University of Technology
for the academic year 2025/2026

Specific rules awarding ranking points

1. Selection teams award ranking points to candidates according to the following criteria:

Criterion	Number of points Ranked	
1. Master's Degree Result	0:÷20	60 points in the case of candidates referred to in § 10 sec. 5 and 6 of the recruitment rules
2. Qualifications and competences for education at the Doctoral School in the selected scientific discipline	0 ÷ 10	
3. Scientific achievements	0:÷30	
4. The concept of the doctoral dissertation	0 ÷ 10	
5. Interview	0 ÷ 40	
Total max.	**110**	

2. Detailed rules for awarding ranking points in individual criteria:

1) Master's Degree Result

Result	Number of points Ranked
Very good with distinction (5W)	20
very good (5)	15
good plus (4+)	10
good (4)	5
below good (under 4)	0

2) Qualifications and competences of a candidate for education at the Doctoral School in a selected scientific discipline

Specification	Number of ranking points
1) documented trips abroad (e.g. Erasmus), internships, individual studies	0 ÷ 5
2) certificates, certificates and attestations confirming the acquisition of qualifications needed in scientific work (postgraduate studies, courses, training, certificate of any foreign language above B2, etc.)	0 ÷ 5

3) Candidate's academic achievements

Specification	Number of ranking points
1) documented scientific publications published in the years 2018-2025, including:	**0 ÷ 30 points**
a) monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 15 points for one monograph
b) chapter in a multi-author monograph from the list referred to in Article 267 section 3 of the Act	0 ÷ 5 points for one chapter – a total of no more than 10 points
c) scientific publication in journals from the list referred to in Article 267 section 3 of the Act	0 ÷ 10 points per publication
d) scientific publication in journals outside the list referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 15 points.
e) participation in a scientific conference with the presentation of the paper and its publication in peer-reviewed post-conference materials, referred to in Article 267 (3) of the Act	0 ÷ 5 points for one publication – in total no more than 10 points.
2) documented awards or scholarships	**0 ÷ 15 points**
a) obtaining an award or scholarship from the minister responsible for higher education and science or the Minister of National Defence	8 points for one award or scholarship
b) obtaining the Rector's award or scholarship	0 ÷ 3 points
c) distinction for the best diploma thesis	0 ÷ 2 points
d) other research awards	0 ÷ 2 points
3) documented achievements in the Students' Scientific Club (KNS)	**0 ÷ 5 points**
1. distinction in the competition for the best student thesis as part of the activities of the Student Research Centre	0 ÷ 3 points;
2. distinction for the speech at the KNS seminar	0 ÷ 2 points
4) documented participation in research projects - based on statements of the principal investigators	**0 ÷ 10 points**

Comments:

1. *Each achievement must be documented in the form of an electronic copy in PDF format*
2. *If the sum of the points in the sub-criteria exceeds the maximum value for that criterion, the maximum number of points for that criterion will be awarded to you*

4) The concept of the doctoral dissertation

Specification	Ranking points
Assessment of the quality and substantive correctness of the concept, in particular the presentation of the topic of the dissertation and the justification of its selection, definition of the research problem, purpose, research questions, hypotheses, methodology and presentation of the current state of research in the field of the adopted topic.	**0 ÷ 10**

Editing requirements: *max. 5000 characters without spaces, Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5; justified text.*

5) Interview

Specification	Ranking points
1) evaluation of the presentation of the concept of the doctoral dissertation in the field of: a) justification for taking up the topic, b) defining the research problem (goal, research questions, hypotheses), c) proposed methodology, d) novelty and originality of the issues raised, e) to present the state of research in the field of project and literature;	**0 ÷ 15**
2) Assessment of knowledge, skills and motivation: a) the ability to justify/defend the presented concept of the doctoral dissertation, b) the ability to conduct a scientific discussion, including coherence and clarity of argumentation, c) general knowledge in the field of scientific discipline, d) motivation to conduct research work.	**0 ÷ 25**

Appendix No. 2
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(academic title/degree)

(name and surname of the potential supervisor)

(scientific discipline represented)

STATEMENT

I declare that if a candidate will be admitted*:

(name and surname of the candidate)

to the Doctoral School of the Military University of Technology for the academic year 2025/2026, I agree to be a scientific supervisor within the research topic:

(research topics)

At the same time, I declare that:

1) I was not the supervisor of 4 doctoral students who were removed from the list of doctoral students due to a negative result of the mid-term evaluation,
2) I did not supervise the preparation of the dissertation by at least 2 persons applying for a doctoral degree who did not receive positive reviews referred to in Article 191 section 1 of the Act.

……. ……..
(date) *(signature of the potential supervisor)*

* delete as appropriate

Appendix No. 3
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(name and surname of the candidate)

(scientific discipline)

The concept of the doctoral dissertation[1]

……..
signature of the candidate

[1] The concept should include: the initial topic of the dissertation and the justification for its selection, the definition of: the research problem, the purpose, the research questions, the hypotheses, the subject of the dissertation methodology and the presentation of the current state of research in the field of the adopted subject matter - **max. 5000 characters without spaces,** Arial font, normal style, size 12, margins: right, left, up, bottom - 2.5 cm, line spacing 1.5, justified text

Appendix No. 4
to the Rules of recruitment to the Doctoral School of the Military University of Technology
for the academic year 2025/2026.

INFORMATION QUESTIONNAIRE

(name and surname of the candidate)

I. BASIC DATA

1. Completed second-cycle (master's) studies

1)	Name of the university	
2)	field of study	
3)	final score	
4)	year of completion	
5)	Title of the diploma thesis	
6)	name and surname of the head of the diploma thesis	

2. Do you have a PhD degree? If so, please attach a copy of your doctoral diploma or provisional certificate – *attachment no. 1*

3. Have you had or are you initiating doctoral proceedings or proceedings for awarding a doctoral degree? If so, please provide the university/institute and scientific discipline and the topic of the dissertation.

4. Have you been or are you a participant of doctoral studies (third-cycle studies)? If so, please provide the university/institute, scientific discipline, year of commencement - year of completion

5. Have you been or are you a doctoral student at a doctoral school? If so , please provide the name of the doctoral school, scientific discipline, date of beginning and end of education

6. Current employment

(name of the workplace, city, position held, status – professional soldier, police officer, prison service officer, civilian, other)

II. QUALIFICATIONS AND COMPETENCES

1. Trips abroad and individual studies:

1) mobility under programs, e.g. Erasmus – *Annex 2*

(name of the programme, date of departure, semester of study, host university, country)

2) foreign internships – *Appendix No. 3*

(name of the traineeship, date, semester of study, host institution, country)

3) individual studies - *Appendix No. 4*

(semester(s) of study, level of study)

2. Certificates and attestations confirming the acquisition of qualifications necessary for scientific work - *Appendix No. 5*

(name of certificate/attestation)

3. Document certifying knowledge of a foreign language at the level of language proficiency above B2 - *Appendix No. 6*[1]

(name of certificate/attestation)

4. Documents certifying knowledge of the Polish language only in the case of foreigners educated in Polish - *Appendix No. 7*[2]

(document name)

III. SCIENTIFIC ACHIEVEMENTS

1. Publication activities in the years 2018 - 2025[3]:

1) monograph from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 8***

(author(s), title, publisher, year of publication, number of points)

[1] documents confirming knowledge of any foreign language at a level above B2, e.g. C1, C2

[2] documents referred to in § 6 section 6 points 1-3

[3] in the case of:

- the monograph should be accompanied by a copy of the title page and an abstract (max. 5 A4 pages),
- chapter in a monograph, scientific publication or paper, longer than 5 pages, a title page and an abstract (max. 3 A4 pages) should be attached, a copy of the entire publication should be attached to 5 pages,

2) chapter in a multi-author monograph, from the list referred to in Article 267 section 3 of the Act - ***Appendix No. 9***

(author(s), title, title of the monograph, publisher, year of publication, number of points)

3) scientific publication in journals from the list of scientific journals referred to in Article 267 (3) of the Act - ***Appendix No. 10***

(author(s), title, journal name, year of publication, number of points)

4) scientific publication in journals outside the list referred to in Article 267 section 3 of the Act - ***Appendix No. 11***

(author(s), title, journal name, year of publication)

5) participation in a scientific conference with a presentation of the paper and its publication in peer-reviewed post-conference materials, in the list referred to in Article 267 (3) of the Act - ***Appendix No. 12***

(name of the conference, date, place, topic of the presentation, author(s)

2. Awards, scholarships obtained

1) awards or scholarships of the minister responsible for higher education and science or the Minister of National Defence – ***Appendix 13***

(name of the award or scholarship, date of award)

2) obtaining the Rector's award or scholarship – ***Appendix No. 14***

(name of the award or scholarship, date of award)

3) distinction for the best diploma thesis – ***attachment No. 15***

(bachelor's/master's thesis, date of award)

4) other awards for research activity – ***Appendix No. 16***

(title of the award, date of award)

3. Achievements in the Students' Scientific Club (SSC)

1) distinction in the competition for the best student thesis as part of the activities of the Committee – ***Appendix No. 17***

(topic of the thesis, date of award)

2) distinction for the presentation at the SSC seminar – ***attachment no. 18***

(topic of the speech, date of awarding the distinction)

4. Participation in research projects in the last 5 years - *attachment no. 19*

Lp.	Project name Research	Time of participation in the project from - to	University, scientific institution where the project is implemented	Academic title/degree name and surname Project Manager	% of the candidate's participation in the project
1					
2					

Comments:

- only attachments in pdf or jpg format are uploaded to the IRK system
- the appendix to the point/subsection of the Questionnaire should contain confirmation of all information indicated in this point/subsection,
- attachments should contain confirmations of awards, scholarships, distinctions in the form of scans of diplomas, certificates, decisions,
- Confirmation of the candidate's participation in research projects is a certificate from the principal investigator, in the case of several certificates, they must be uploaded in one file
- in the case of a large file size, it is possible to split the file and upload it as additional attachments available in the IRK form,
- the size of all files should not exceed 50 MB.

city, state, date	*signature of the candidate*

Appendix No. 5
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

List
documents confirming knowledge of English
at least B2 level

In the recruitment procedure to the Doctoral School of MUT, the following documents are accepted, confirming the candidate's knowledge of English at least at the B2 level on the scale of global language proficiency according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)":

1. A diploma of graduation containing a graphic sign informing about the 6th or 7th level. The Polish Qualifications Framework is assigned to full qualifications included in the integrated qualifications system, if the diploma supplement contains information that the only or basic foreign language taught during the studies was English and the learning outcomes were achieved for English.
2. Information in the supplement to the diploma of graduation that you have passed the English language exam at least at B2 level.
3. Diploma in English Philology.
4. A certificate confirming the knowledge of English issued by the National School of Public Administration as a result of a linguistic verification procedure.
5. Certificates confirming the achievement of the Standard Language Profile (SPJ) 3232 of English proficiency according to the NATO Standardization Agreement STANAG 6001.
6. A document confirming the completion of studies or postgraduate studies abroad or in the Republic of Poland, if the language of instruction was English.
7. A document issued abroad recognized as equivalent to a secondary school-leaving certificate if the language of instruction was English.
8. International Baccalaureate Diploma or European Baccalaureate Diploma.
9. Certificate of passing the departmental exam in English, at a level corresponding to at least B2, issued by the Ministry of Foreign Affairs or other central administration offices.
10. A document confirming entry on the list of sworn translators in the Republic of Poland or a document confirming the qualifications of a sworn translator in another Member State of the European Union, a member state of the European Free Trade Association (EFTA) – a party to the Agreement on the European Economic Area or in the Swiss Confederation.
11. Certificates confirming knowledge of English at least at B2 level issued by:
    1) Cambridge Assessment English,
    2) LanguageCert Polska,
    3) Educational Testing Service (ETS),
    4) European Consortium for the Certificate of Attainment in Modern Languages (ECL),
    5) Oxford Test of English (OTE),
    6) Trinity College: Integrated skills in English (ISE),

7) City & Guilds, City & Guilds Pitman Qualifications, Pitman Qualifications Institute,
8) Pearson Qualifications: Pearson test of English - PTE General, Pearson test of English - PTE Academic, PEIC, LCCI qualifications,
9) Cambridge Assessment English, London Chamber of Commerce and Industry Examinations Board. British Council, IDP IELTS Australia: International English Language, Education Development International (EDI), University of Cambridge, ESOL Examinations,
10) TELC GmbH, WBT Weiterbildungs -Testsysteme GmbH,
11) universities and institutions associated with the Association of Language Testers in Europe (ALTE), the Network of University Language Testers in Europe (NULTE), the Association of Academic Foreign Language Teaching Centres (SERMO).

Appendix No. 6
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

Information clause

Pursuant to Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L.2016.119.1, hereinafter referred to as "GDPR", I hereby inform you that:

1. The administrator of your personal data is the Military University of Technology with its registered office in Warsaw (code: 00-908) at 2 gen. Sylwestra Kaliskiego Street, Poland.
2. The Data Controller has appointed a Data Protection Officer to supervise the correctness of personal data processing, who can be contacted via the following e-mail address: iod@wat.edu.pl.
3. Your personal data will be processed for recruitment purposes to the Doctoral School, and after admission they will be processed for the purposes of documenting the course of education and for statutory, statistical and archiving purposes, as well as for the purpose of pursuing and defending against possible claims.
4. The data provided will be processed on the basis of Article 6(1)(c) and (e) of the GDPR, i.e. in order to comply with a legal obligation to which the Controller is subject and when the processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the Controller.
5. In the case of awarding an increased scholarship amount, data of special categories in the form of a person's health condition (including disability) will be processed on the basis of Article 9(2)(b), i.e. the processing is necessary for the fulfilment of duties and performance by the Administrator in the field of labour law, social security and social protection.
6. Providing data is voluntary, but necessary to achieve the purposes for which it was collected. Failure to provide them will make it impossible to conduct recruitment and admission to the first year of education at the Doctoral School.
7. Personal data will not be made available to other recipients, except for the minister competent for science and higher education, the Minister of National Defence and cases provided for by law.
8. The data will be stored for the period necessary to carry out all activities related to the recruitment process, and after admission to the Doctoral School for a period of 50 years from the completion of education;
9. You have the right to access your data and, subject to the provisions of law: the right to rectify, delete, limit processing.
10. You have the right to lodge a complaint with the President of the Office for Personal Data Protection.
11. Persons whose personal data is processed by the University have the right to lodge a complaint with the competent supervisory authority, which is the

President of the Office for Personal Data Protection, if they believe that the processing of personal data violates the generally applicable regulations in this respect.

I confirm that I have read and acknowledge the above information.

....

city, state, date *signature of the candidate*

Appendix No. 7
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(name and surname of the candidate)

(scientific discipline)

STATEMENT

Aware of the criminal liability for providing false information, I declare that as of **October 1, 2025.**:

1. The Doctoral School of the Military University of Technology will be the only doctoral school where I will carry out education;
2. I have/do not have* a doctoral degree[1];
3. I have/do not have* the certificate(s):[2]
   1) on disability*,
   2) on the degree of disability* referred to in Article 5 and Article 62 of the Act of 27 August 1997 on vocational and social rehabilitation and employment of persons with disabilities (i.e. Journal of Laws of 2024, item 44, as amended).

……..
date and legible signature of the candidate

Attachments:

1. ……
2. ……

**- delete as appropriate*

[1] in the case of holding a doctoral degree, a copy of the diploma on awarding the doctoral degree or a provisional certificate should be attached
[2] If you have a certificate, you must attach a copy of it

Appendix No. 8
to the Rules of recruitment to the Doctoral School of MUT
for the academic year 2025/2026

(name and surname of the candidate)

(scientific discipline)

STATEMENT

I declare that I have a documented knowledge of English at least at B2 level on the global scale of language proficiency according to the "Common European Framework of Reference for Languages: learning, teaching, assessment (CEFR)" in accordance with Annex 5 to the Rules of Admissions to the Doctoral School of Military University of Technology for the academic year 2025/2026.

The confirmation of the above-mentioned acquaintance is[1]:

(Diploma Reference, Supplement, Name of Certificate/Attestation)

……..
date and legible signature of the candidate

Attachment[2]:

1. ……

[1] only documents included in Annex 5 to the Rules of recruitment to the Doctoral School of MUT for the academic year 2025/2026 may be indicated

[2] a copy of a document confirming the knowledge of English indicated by the candidate

Wojskowa Akademia Techniczna

Bylaw
Rector of the Military University of Technology
Jarosław Dąbrowski

No. 32/RKR/2022 of 13 April 2022

on the determination of the criteria for the mid-term evaluation of doctoral students of the Doctoral School of the Jarosław Dąbrowski Military University of Technology

Pursuant to § 18 (1) of the Statute of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021) and § 28 (3) of the Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology", the following is ordered:

§ 1

1. Mid-term evaluation of doctoral students of the Doctoral School of Military University of Technology (SDR WAT) is carried out in the middle of the period of education specified in the SDR MUT education program, but not later than by the end of the fourth semester of education, subject to paragraph 2.
2. In particularly justified cases, at the request of a doctoral student, the mid-term evaluation may be carried out by the end of the first month of the fifth semester of education.
3. The schedule of the mid-term evaluation is determined in the form of a decision by the Director of the SDR MUT and made public within 30 days from the date of the beginning of the fourth semester of education, maintaining at least a one-month period until the first evaluation.

§ 2

1. The mid-term evaluation is carried out by the Committee for Mid-term Evaluation, hereinafter referred to as the "Committee", appointed by the Rector for each scientific discipline conducted at the SDR MUT.
2. The Commission's work phases include:
   1) analysis of the documentation referred to in § 3 section 4 point 1;

2) assessment of self-presentation and evaluation interview with a doctoral student, referred to in § 3 section 4 points 2 and 3;
3) determining the result of the mid-term evaluation of the doctoral student and preparing a justification.

3. The mid-term evaluation of a doctoral student ends with a positive or negative result.
4. The result of the assessment along with the justification is public.

§ 3

1. The mid-term evaluation covers the period from the commencement of education by the doctoral student at the Doctoral School to the date of submission of the mid-term report.
2. The template of the mid-term report and the supervisor's mid-term opinion, as well as the dates, form and place of their submission, are specified by the Director of the Doctoral School.
3. In particular, the implementation of the doctoral student's individual research plan (IRP) is subject to mid-term evaluation.
4. The mid-term evaluation of a doctoral student includes the assessment of:
   1) documents related to the implementation of an individual research plan by the doctoral student and the preparation of the doctoral dissertation:
      a) reports on the subject Analysis of the research area,
      b) individual research plan,
      c) a semester report on the implementation of the IRP after the third semester of education together with a semester opinion of the supervisor/supervisors,
      d) the mid-term report together with the mid-term opinion of the supervisor or supervisors;
   2) self-presentation of the PhD student (max. 20 minutes) on the implementation of the individual research plan;
   3) an evaluation interview (scientific discussion) with a doctoral student on issues related to the implementation of an individual research plan.
2. The evaluation interview with the doctoral student is conducted by the committee immediately after the presentation of the doctoral student.

§ 4

1. The committee determines the result of the mid-term evaluation of a doctoral student on the basis of the following criteria:
   1) timeliness of the implementation of the stages of preparation of the doctoral dissertation specified in the IRP;
   2) compliance of the completed stages of preparation of the doctoral dissertation (tasks, issues, research) with those planned at the IRP;
   3) compliance of the degree of implementation (percentage share in the total dissertation) of the planned stages of preparation of the doctoral dissertation included in the IRP;
   4) scientific activity of a doctoral student - compliance and degree of implementation of planned projects (conferences, internships, publications);
   5) the stage of advancement of the preparation of the doctoral dissertation and the possibility of timely submission of the dissertation.

2. Each member of the committee evaluates the doctoral student within the framework of individual criteria, determining the result as positive or negative.
3. When assessing individual criteria, the members of the committee may additionally take into account and take into account:
    1) scientific achievements of a doctoral student;
    2) participation of a doctoral student in projects, grants, programs,
    3) planned undertakings of scientific activity in semesters V-VIII (in the absence of such undertakings in semesters I-IV),
    4) consent of the Director of the Doctoral School to postpone the date of the mid-term evaluation,
    5) delays in the implementation of the individual research plan caused by justified random factors, e.g. inability to conduct an internship, research, participate in conferences, if they have been indicated in the doctoral student's mid-term report and supervisor's opinion.

§ 5

1. The Committee, for each criterion referred to in § 4 section 1, determines the final result as positive or negative.
2. A positive result of the criterion is obtained by a doctoral student if at least 2 members of the committee have determined a positive result for this criterion.
3. A positive mid-term evaluation of a doctoral student is conditional on obtaining positive grades in all the criteria referred to in paragraph 1, subject to paragraph 4.
4. Failure by a doctoral student to submit a mid-term report together with the opinion of the supervisor or supervisors or failure to participate in the evaluation interview within the set deadline results in a negative result of the mid-term evaluation, subject to paragraph 5.
5. In justified cases, at the request of a doctoral student, the director of the doctoral school may set a new date for the submission of a mid-term report or an evaluation interview. The doctoral student attaches the supervisor's opinion to the application.
6. The committee prepares the result of the mid-term evaluation of the doctoral student within 7 days from the date of the mid-term evaluation of the doctoral student, and the justification of the result of the mid-term evaluation within 14 days from the date of the evaluation. In the justification, the committee may specify recommendations for changes in the individual research plan. The result and justification are immediately submitted by the committee to the director of the Doctoral School.

§ 6

The decision shall enter into force on the date of signing.

Rector

(-) Col. Professor Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 3/SDR/2021 of 15 March 2021

on the establishment of the Schedule for conducting the mid-term evaluation of doctoral students of the Military University of Technology Doctoral School in the academic year 2020/2021

Pursuant to § 27 section 1 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. A schedule for conducting the mid-term evaluation of doctoral students of the second year of education in individual scientific disciplines of the Doctoral School in the academic year 2020/2021, which is attached to the decision, is hereby established.
2. The individual date and time of the mid-term evaluation will be announced on the Doctoral School's website and communicated to doctoral students by e-mail by 31 May 2021.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

/--/ Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology
No. 3/SDR/2021 of 15 March 2021

Schedule
conducting mid-term evaluation for doctoral students of the second year of education
Doctoral School in the academic year 2020/2021

Lp.	Scientific discipline	Number of PhD students	Assessment Date, Start Time
1	Automation, Electronics and Electrical Engineering	7	18 June 2021, 9.00
2	Technical Informatics and Telecommunications	6	17 June 2021, 9.00 a.m.
3	Civil Engineering & Transportation	2	23 June 2021, 9.00 a.m.
4	Materials Engineering	1	23 June 2021, 11.00 a.m.
5	Mechanical Engineering	9	15 and 16 June 2021, 9.00 a.m.
6	Security Sciences	8	21 June 2021, 9.00 a.m.
7	Chemical Sciences	4	22 June 2021, 9.00 a.m.
	Total	**37**	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 8/SDR/2022 of 1 April 2022

on the establishment of the Schedule for conducting the mid-term evaluation of doctoral students of the Doctoral School of the Military University of Technology in the academic year 2021/2022

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 26(1) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The schedule for conducting the mid-term evaluation of second-year doctoral students in individual scientific disciplines of the Doctoral School in the academic year 2021/2022, which is attached to the decision, is hereby established.
2. The individual date and time of the mid-term evaluation will be announced on the Doctoral School's website and communicated to doctoral students by e-mail by 31 May 2022.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology
No. 8/SDR/2022 of 1 April 2022

Schedule
conducting a mid-term evaluation of doctoral students of the second year of education
at the Doctoral School in the academic year 2021/2022

Lp.	Scientific discipline	Number of PhD students	Assessment Date, Start Time
1	Automation, Electronics and Electrical Engineering	**9**	20 and 21 June 2022, 9.00
		1 *(NAWA scholarship holder)*	6 September 2022, 12.00 p.m.
2	Technical Informatics and Telecommunications	**7**	22 June 2022, 9.00 a.m.
3	Civil Engineering & Transportation	**1**	June 20, 2022, 1.00 p.m.
4	Materials Engineering	**2**	21 June 2022, 1.00 p.m.
		1 *(participant of the fourth edition of the "Implementation Doctorate" program)*	5 September 2022, 9.00 a.m.
5	Mechanical Engineering	**16**	23, 24 and 27 June 2022, 9.00 a.m.
		3 *(participants of the fourth edition of the "Implementation Doctorate" program)*	6 September 2022, 9.00 a.m.
6	Security Sciences	**12**	28 and 29 June 2022, 9.00 a.m.
7	Chemical Sciences	**5**	June 30, 2022, 9.00 a.m.
		2 *(participant of the fourth edition of the "Implementation Doctorate" program and a doctoral student after the suspension of education)*	5 September 2022, 11.00 a.m.
Total		**59**	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 6/SDR/2023 of 15 March 2023

on the establishment of the Schedule for conducting the mid-term evaluation of doctoral students of the Military University of Technology Doctoral School in the academic year 2022/2023

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 26(1) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. A schedule for conducting the mid-term evaluation of doctoral students of the second year of education in individual scientific disciplines of the Doctoral School in the academic year 2022/2023, which is attached to the decision, is hereby established.
2. The individual date and time of the mid-term evaluation will be announced on the Doctoral School's website and communicated to doctoral students by e-mail by 31 May 2023.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology
No. 6/SDR/2023 of 15 March 2023

Schedule
conducting a mid-term evaluation of doctoral students of the second year of education
at the Doctoral School in the academic year 2022/2023

Lp.	Scientific discipline	Number of PhD students	Assessment Date, Start Time
1	Automation, Electronics, Electrical Engineering and Space Technologies	**10**	26 and 27 June 2023, 9.00 a.m.
		1 *(participant of the fifth edition of the "Implementation Doctorate" program)*	5 September 2023, 9.00 a.m.
2	Technical Informatics and Telecommunications	**12**	26 and 27 June 2023, 9.00 a.m.
3	Civil engineering, surveying and transport	**1**	30 June 2023, 9.00 a.m.
4	Materials Engineering	**2**	30 June 2023, 10.00 a.m.
5	Mechanical Engineering	**9**	28 and 29 June 2023, 9.00 a.m.
		2 *(participants of the fifth edition of the "Implementation Doctorate" program)*	5 September 2023, 10.00 a.m.
6	Chemical Sciences	**3**	30 June 2023, 12.00 p.m.
7	Security Sciences	**12**	28 and 29 June 2023, 9.00 a.m.
		1 *(participant of the fifth edition of the "Implementation Doctorate" program)*	5 September 2023, 12.00 p.m.
Total		**53**	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
Jarosław Dąbrowski

No. 2/SDR/2024 of 28 March 2024

on the establishment of the Schedule for the mid-term evaluation of doctoral students of the Doctoral School of the Jarosław Dąbrowski Military University of Technology in the academic year 2023/2024

Pursuant to § 103 sec. 6 point 11 of the Statute of the Military University of Technology of Jarosław Dąbrowski constituting an attachment to the resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology of Jarosław Dąbrowski (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 28 sec. 1 of the Regulations of the Doctoral School of the Military University of Technology of Jarosław Dąbrowski constituting an attachment to the resolution 62/WAT/2023 of of 27 April 2023 on the adoption of the "Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology", the following is resolved:

§ 1

1. A schedule for the mid-term evaluation of second-year doctoral students in individual scientific disciplines of the Doctoral School in the academic year 2023/2024 is established, which is attached to the decision.
2. The individual date and time of the mid-term evaluation will be announced on the Doctoral School's website and communicated to doctoral students by e-mail by May 31, 2024.

§ 2

The decision shall enter into force on the date of signing.

Manager
Doctoral School of the Military
University of Technology

(--) Piotr ZALEWSKI, PhD, Eng., prof.
MUT

Annex to the Decision
Director of the Doctoral School of the Military University of Technology
No. 2/SDR/2024 of 28 March 2024

Schedule
conducting a mid-term evaluation of second-year doctoral students
at the Doctoral School in the academic year 2023/2024

Lp.	Scientific discipline	Number of PhD students	Assessment deadline Starting time
1	automation, electronics, electrical engineering and space technologies	**8**	23 September 2024, 9.00 a.m.
2	Informatics and Telecommunications	**14**	23 and 24 September 2024, 9.00 a.m.
3	Civil Engineering, Geodesy and Transport	**6**	24 September 2024, 9.00 a.m.
4	Materials Engineering	**4**	25 September 2024, 9.00 a.m.
5	Mechanical Engineering	**15**	25 and 26 September 2024, 9.00 a.m.
6	chemical sciences	**4**	27 September 2024, 9.00 a.m.
7	security sciences	**12**	26 and 27 September 2024, 9.00 a.m.
	Total	**63**	

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No 9/SDR/2025 of 25 April 2025

on the establishment of the Schedule for conducting the mid-term evaluation of doctoral students of the Military University of Technology Doctoral School in the academic year 2024/2025

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 21(1) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to Resolution No. 28/WAT/ 2024 of 25 April 2024 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The schedule for conducting the mid-term evaluation of doctoral students of the second year of education at the WAT Doctoral School in individual scientific disciplines in the academic year 2024/2025, which is attached to the decision, is hereby established.
2. The individual date and time of the mid-term evaluation will be communicated to doctoral students by e-mail by 30 July 2025.

§ 2

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Annex to the decision
Director of the Doctoral School of the Military University of Technology
No. 9/SDR/2025 of 25 April 2025

Schedule
conducting a mid-term evaluation of doctoral students of the second year of education
at the Doctoral School in the academic year 2024/2025

Lp.	Scientific discipline	Number of PhD students subject to assessment	Assessment Deadline Start time
1	Automation, Electronics, Electrical Engineering and Space Technologies	6	22 September 2025, 9.00
2	Technical Informatics and Telecommunications	13	22 and 23 September 2025, 9.00 a.m.
3	Civil engineering, surveying and transport	6	23 September 2025, 9.00 a.m.
4	Materials Engineering	2	24 September 2025, 9.00 a.m.
5	Mechanical Engineering	13	25 and 26 September 2025, 9.00 a.m.
6	Chemical Sciences	2	24 September 2025, 9.00 a.m.
7	Security Sciences	10	25 and 26 September 2025, 9.00 a.m.
Total		**52**	

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology

No. 109/RKR/2021 of 25 May 2021

on the appointment of the Committee for the Mid-Term Evaluation of Doctoral Students of the Doctoral School of the Military University of Technology for the academic year 2020/2021

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the announcement of the Rector of the Military University of Technology No. 2/WAT/2019 of 9 October 2019), in connection with § 28 section 4 of the Annex to the Resolution No. 49/WAT/2019 of the Senate of the Military University of Technology of 27 June 2019 on the adoption of the "Regulations of the Doctoral School of the wski Military University of Technology", it is decided as follows:

§ 1

In the academic year 2020/2021, the following are appointed to carry out the mid-term evaluation of doctoral students of the second year of education at the Jarosław Dąbrowski Doctoral School of the Military University of Technology:

1. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Automation, Electronics and Electrical Engineering composed of:
   1) Chairman: Prof. Waldemar ŻENDZIAN - Military University of Technology;
   2) Members:
      - Mateusz PASTERNAK, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
      - Erwin MACIAK, PhD, DSc, Eng. - Silesian University of Technology;
2. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Technical Informatics and Telecommunications, composed of:
   1) Chairman: Bolesław SZAFRAŃSKI, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Jerzy BALICKI, PhD, DSc, Eng., Prof. WUT - Warsaw University of Technology;
      - Krzysztof MURAWSKI, PhD, DSc, Eng., Prof. WAT - Military University of Technology;

3. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Civil Engineering and Transport, composed of:

1) Chairman: Prof. Janusz BOGUSZ - Military University of Technology;
2) Members:
   - Wojciech MOČKO, PhD, DSc, Eng., Prof. ITS - Institute of Motor Transport;
   - Dariusz GOTLIB, PhD, DSc, Eng., Prof. WUT - Warsaw University of Technology;

4. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Materials Engineering composed of:

1) Chairman: Prof. Zbigniew BOJAR - Military University of Technology;
2) Members:
   - Małgorzata NOREK, PhD, DSc, Prof. WAT – Military University of Technology;
   - Dariusz OLESZAK, PhD, DSc, Eng., Professor of the University – Warsaw University of Technology;

5. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Mechanical Engineering composed of:

1) Chairman: Prof. Radosław TRĘBIŃSKI - Military University of Technology;
2) Members:
   - Prof. Krzysztof Sławomir SIBILSKI - Warsaw University of Technology;
   - Prof. Zdzisław BOGDANOWICZ - Military University of Technology;

6. Committee for Mid-term Evaluation of PhD Students in the Scientific Discipline of Chemical Sciences composed of:

1) Chairman: Prof. Marzena TYKARSKA - Military University of Technology;
2) Members:
   - Prof. Robert NOWAKOWSKI - Institute of Physical Chemistry of the Polish Academy of Sciences;
   - Colonel Przemysław KULA, PhD, DSc, Eng., Prof. WAT - Military University of Technology;

7. The Committee for the Mid-term Evaluation of Doctoral Students in the Scientific Discipline of Safety Science , composed of:

1) Chairman: Colonel Szymon MITKOW, PhD, DSc, Prof. WAT - Military University of Technology;
2) Members:
   - Jacek BIL, PhD, DSc, Prof. WAT - Military University of Technology
   - Colonel Krzysztof DRABIK, PhD, DSc, Prof. ASzWoj – Academy of War Arts.

§ 2

1. Persons participating in the work of the committee referred to in § 1, employed outside the Military University of Technology, are entitled to remuneration in the amount of 20% of the professor's salary.
2. The remuneration is paid after the completion of the work of the committee.

§ 3

The mid-term evaluation committees, in the compositions specified in § 1, operate from 1 June 2021 to 31 October 2021.

§ 4

The decision enters into force on the day of signing.

Rector

(--) Col. Prof. Przemysław WACHULAK

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology

No. 202/RKR/2022 of 25 May 2022

on the appointment of the Committee for the Mid-term Evaluation of Doctoral Students of the Doctoral School of the Military University of Technology for the academic year 2021/2022

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 27 sections 1 and 3 of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

In the academic year 2021/2022, the following are appointed to carry out the mid-term evaluation of doctoral students of the second year of education at the Doctoral School of the Military University of Technology:

1. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Automation, Electronics and Electrical Engineering composed of:
   1) Chairman: Prof. Andrzej Zając - Military University of Technology;
   2) Members:
      - Mateusz Pasternak, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
      - Erwin Maciak, PhD, DSc, Eng., Professor of the University - Silesian University of Technology.
2. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Technical Informatics and Telecommunications, composed of:
   1) chairman: Tadeusz Nowicki, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Jarosław Michalak, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
      - Captain Tomasz Praczyk, PhD, DSc, Eng., Prof. AMW - Naval Academy.

3. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Civil Engineering and Transport, composed of:
   1) Chairman: Anna Fryśkowska-Skibniewska, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Stanisław Mikrut, PhD, DSc, Eng., Prof. AGH University of Science and Technology - AGH University of Science and Technology;
      - Dariusz Gotlib, PhD, DSc, Eng., Prof. WUT - Warsaw University of Technology.
4. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Materials Engineering composed of:
   1) Chairman: Col. Paweł Madejczyk, PhD, DSc, Eng., Professor of the University – Military University of Technology;
   2) Members:
      - Prof. Dominik Dorosz – AGH University of Science and Technology;
      - Paweł Marć, PhD, DSc, Eng., Prof. WAT – Military University of Technology.
5. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Mechanical Engineering composed of:
   1) Chairman: Prof. Radosław Trębiński - Military University of Technology;
   2) Members:
      - Prof. Zdzisław Bogdanowicz - Military University of Technology;
      - Professor Grzegorz Kowaleczko – Air Force Institute of Technology.
6. Committee for Mid-term Evaluation of PhD Students in the Scientific Discipline of Chemical Sciences composed of:
   1) Chairman: Prof. Marzena Tykarska - Military University of Technology;
   2) Members:
      - Wiktor Lewandowski, PhD - Centre for Biological and Chemical Sciences, University of Warsaw;
      - Prof. Stanisław Cudziło - Military University of Technology.
7. The Committee for the Mid-term Evaluation of Doctoral Students in the Scientific Discipline of Safety Science , composed of:
   1) Chairman – Colonel Konrad Stańczyk, PhD, DSc, Prof. WAT - Military University of Technology;
   2) Members:
      - Sławomir Bartosiewicz, PhD, DSc, Prof. WAT- Military University of Technology;
      - Marcin Jurgielewicz, PhD, DSc, Eng., Prof. PRz, Rzeszów University of Technology.

§ 2

1. Persons participating in the work of the committee referred to in § 1, employed outside the Military University of Technology, are entitled to remuneration in the amount of 20% of the professor's salary.
2. The remuneration is paid after the completion of the work of the committee.

§ 3

The mid-term evaluation committees, in the compositions specified in § 1, operate from 1 June 2022 to 31 October 2022.

§ 4

The decision enters into force on the day of signing.

Rector

Col. Prof. Przemysław Wachulak

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology

No. 153/RKR/2023 of 30 May 2023

on the appointment of the Committee for the Mid-Term Evaluation of Doctoral Students of the Doctoral School of the Military University of Technology for the academic year 2022/2023

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. the Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 27 sections 1 and 3 of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology" (i.e. Announcement of the Rector of the Military University of Technology No. 4/WAT/2022 of 5 October 2022), it is decided as follows:

§ 1

In the academic year 2022/2023, the following are appointed to carry out the mid-term evaluation of doctoral students of the second year of education at the Doctoral School of the Military University of Technology:

1. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Automation, Electronics, Electrical Engineering and Space Technologies composed of:
   1) Chairman: Prof. Andrzej Zając - Military University of Technology;
   2) Members:
      - Prof. Mateusz Pasternak - Military University of Technology;
      - Erwin Maciak, PhD, DSc, Eng., Professor of the University - Silesian University of Technology.
2. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Technical Informatics and Telecommunications, composed of:
   1) Chairman: Ryszard Antkiewicz, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Grzegorz Borowik, PhD, DSc, Eng., Prof. UTH - University of Technology and Economics;
      - Jarosław Michalak, PhD, DSc, Eng., Prof. WAT - Military University of Technology.

3. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Civil Engineering, Geodesy and Transport composed of:
   1) Chairman: Krzysztof Pokonieczny, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Piotr Smarzewski, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
      - Michał Piasecki, PhD, DSc, Eng., Prof. ITB - Building Research Institute.
4. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Materials Engineering composed of:
   1) Chairman: Prof. Zbigniew Bojar – Military University of Technology;
   2) Members:
      - Stanisław Jóźwiak, PhD, DSc, Eng., Prof. WAT – Military University of Technology;
      - Marek Krasnowski, PhD, DSc, Eng. – Warsaw University of Technology.
5. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Mechanical Engineering composed of:
   1) Chairman: Prof. Radosław Trębiński - Military University of Technology;
   2) Members:
      - Prof. Zdzisław Bogdanowicz - Military University of Technology;
      - Professor Grzegorz Kowaleczko – Air Force Institute of Technology.
6. Committee for Mid-term Evaluation of PhD Students in the Scientific Discipline of Chemical Sciences composed of:
   1) Chairman: Prof. Marzena Tykarska - Military University of Technology;
   2) Members:
      - Prof. Mariusz Kluska - University of Life Sciences and Humanities in Siedlce;
      - Krzysztof Kuśmierek, PhD, DSc, Professor of the Military University of Technology - Military University of Technology.
7. The Committee for the Mid-term Evaluation of Doctoral Students in the Scientific Discipline of Safety Science, composed of:
   1) Chairman – Sławomir Byłeń, PhD, DSc, Prof. WAT - Military University of Technology;
   2) Members:
      - Prof. Zbigniew Ścibiorek - International University of Logistics and Transport
      - Włodzimierz Fehler, PhD, DSc, Prof. UPH - University of Life Sciences and Humanities.

§ 2

1. Persons participating in the work of the committee referred to in § 1, employed outside the Military University of Technology, are entitled to remuneration in the amount of 20% of the professor's salary.
2. The remuneration is paid after the completion of the work of the committee.

§ 3

The mid-term evaluation committees, in the compositions specified in § 1, operate from 15 June 2023 to 31 October 2023.

§ 4

The decision enters into force on the day of signing.

Rector

Brig. Gen. Prof. Przemysław Wachulak

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Decision
Rector of the Military University of Technology
Jarosław Dąbrowski

No. 180/RKR/2024 of 17 June 2024

on the appointment of the Commission for the mid-term evaluation of doctoral students of the Doctoral School of the Jarosław Dąbrowski Military University of Technology for the academic year 2023/2024

Pursuant to § 18 (1) of the Statute of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 29 (1) and (3) of the Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology constituting an attachment to the resolution No. 62/WAT/2023 of 27 April 2023 on the adoption of the "Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology", the following is resolved:

§ 1

The following are appointed to conduct the mid-term evaluation of second-year doctoral students at the Doctoral School of the Jarosław Dąbrowski Military University of Technology subject to evaluation in the academic year 2023/2024:

1. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Automation, Electronics, Electrical Engineering and Space Technologies, composed of:
   1) chairman: Prof. Andrzej Zając, PhD, DSc, Eng. - Military University of Technology;
   2) Members:
      - Professor Mateusz Pasternak - Military University of Technology;
      - Erwin Maciak, PhD, DSc, Eng., Associate Professor - Silesian University of Technology.
2. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Technical Informatics and Telecommunications, composed of:

1) chairman: Bolesław Szafrański, PhD, DSc, Eng., prof. MUT - Military University of Technology;
2) Members:
   - Maria Ganzha, Ph.D. - Warsaw University of Technology;
   - Janusz Dudczyk, PhD, DSc, Eng. - Military University of Technology.

3. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Civil Engineering, Geodesy and Transport, composed of:
   1) chairman: Prof. Adam Stolarski, PhD, DSc, Eng. - Military University of Technology;
   2) Members:
      - Professor Andrzej Świderski - Motor Transport Institute;
      - Kamil Kowalczyk, PhD, DSc, Eng., Professor of UWM - University of Warmia and Mazury in Olsztyn.

4. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Materials Engineering, composed of:
   1) chairman: Prof. Krzysztof Jóźwikowski – Military University of Technology;
   2) Members:
      - Małgorzata Norek, PhD, DSc, Associate Professor – Military University of Technology;
      - Adam Dębski, PhD, DSc, Eng., Professor of the Polish Academy of Sciences – Institute of Metallurgy and Materials Science of the Polish Academy of Sciences.

5. The Committee for the Mid-Term Evaluation of PhD Students in the Discipline of Mechanical Engineering, composed of:
   1) chairman: Prof. Zdzisław Bogdanowicz, PhD, DSc, Eng. - Military University of Technology;
   2) Members:
      - Professor Grzegorz Kowaleczko – Air Force Institute of Technology;
      - Zbigniew Leciejewski, PhD, DSc, Eng. - Military University of Technology.

6. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Chemical Sciences, composed of:
   1) chairman: Magdalena Urbańska, PhD, DSc, Eng., Professor of the Military University of Technology - Military University of Technology;
   2) Members:
      - Professor Agnieszka Woźniak - Warsaw University of Technology;
      - Jarosław Puton, PhD, DSc, Eng., Associate Professor - Military University of Technology.

7. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline
   of Security Science, composed of:
   1) Chairman – Adam Ostanek, PhD, DSc, Associate Professor – Military University of Technology;
   2) Members:

- Col. Konrad Stańczyk, PhD, DSc, Associate Professor - Military University of Technology;
- Professor Tomasz Kośmider – University of Justice.

§ 2

1. Persons participating in the work of the committee referred to in § 1 employed outside the Military University of Technology are entitled to remuneration in the amount of 20% of the professor's salary.
2. The remuneration is paid after the completion of the commission's work.

§ 3

The mid-term evaluation committees, in the compositions specified in § 1, operate from 1 August 2024 to 31 October 2024.

§ 4

The decision shall enter into force on the date of signing.

With the authority of the Rector
Military University of Technology

Piotr Zalewski, PhD, Eng.,
Associate Professor at the Military
University of Technology

Prepared by: Dariusz Podbielski – SDR WAT

Wojskowa Akademia Techniczna

Case No.:

Decision
Rector of the Military University of Technology
nr /RKR/ 215 2025 of 27 June 2025

on the appointment of the Committee for the Mid-Term Evaluation of Doctoral Students of the Doctoral School of the Military University of Technology for the academic year 2024/2025

Pursuant to § 18 section 1 of the Statute of the Military University of Technology constituting an annex to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 2/WAT/2024 of 27 March 2024), in connection with § 28 sections 1 and 3 of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to Resolution No. 28/WAT/ 2024 of 25 April 2024 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

The following are appointed to carry out the mid-term evaluation of doctoral students of the second year of educationat the Military University of Technology Doctoral School who are subject to evaluation in the academic year 2024/2025:

1. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Automation, Electronics, Electrical Engineering and Space Technologies composed of:
   1) Chairman: Prof. Mateusz Pasternak - Military University of Technology;
   2) Members:
      - Erwin Maciak, PhD, DSc, Eng., Professor at the University of Silesia - Silesian University of Technology;
      - Marek Piszczek, PhD, DSc, Eng., Prof. WAT - Military University of Technology.
2. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Technical Informatics and Telecommunications, composed of:
   1) Chairman: Arkadiusz Orłowski, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Jarosław Michalak, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
      - Grażyna Ślusarczyk, PhD, DSc, Associate Professor of the Jagiellonian University - Jagiellonian University.

3. The Committee for the Mid-Term Evaluation of PhD Students in the Scientific Discipline of Civil Engineering, Geodesy and Transport composed of:
   1) Chairman: Prof. Adam Stolarski - Military University of Technology;
   2) Members:
      - Prof. Jerzy Merkisz - Poznań University of Technology;
      - Jacek Łubczonek, PhD, DSc, Eng., Prof. PM - Maritime University of Technology in Szczecin.
4. The Committee for Mid-Term Evaluation of PhD Students in the Scientific Discipline of Materials Engineering composed of:
   1) Chairman: Prof. Jarosław Rutkowski - Military University of Technology;
   2) Members:
      - Prof. Krzysztof Jóźwikowski – Military University of Technology
      - Tomasz Mościcki, PhD, DSc, Eng. - Institute of Fundamental Technological Problems of the Polish Academy of Sciences.
5. The Committee for the Mid-term Evaluation of PhD Students in the Scientific Discipline of Mechanical Engineering composed of:
   1) Chairman: Volodymyr Hutsaylyuk, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Professor Grzegorz Kowaleczko – Military Aviation Academy;
      - Wojciech Kaczmarek, PhD, DSc, Eng., Prof. WAT - Military University of Technology.
6. Committee for Mid-term Evaluation of PhD Students in the Scientific Discipline of Chemical Sciences composed of:
   1) Chairman: Przemysław Kula, PhD, DSc, Eng., Prof. WAT - Military University of Technology;
   2) Members:
      - Prof. Krzysztof Czupryński - Military University of Technology;
      - Prof. Tomasz Ligor – Nicolaus Copernicus University in Toruń.
7. The Committee for the Mid-term Evaluation of Doctoral Students in the Scientific Discipline of Safety Science, composed of:
   1) Chairman – Sławomir Augustyn, PhD, DSc, Prof. WAT - Military University of Technology;
   2) Members:
      - Prof. Andrzej Pieczywok - Kazimierz Wielki University in Bydgoszcz;
      - Ireneusz Dziubek, PhD – President Stanisław Wojciechowski University of Kalisz.

§ 2

1. Persons participating in the work of the committee referred to in § 1, employed outside the Military University of Technology, are entitled to remuneration in the amount of 20% of the professor's salary.

2. The remuneration is paid after the completion of the work of the committee.

§ 3

The mid-term evaluation committees, in the compositions specified in § 1, operate from 1 September 2025 to 30 November 2025.

§ 4

The decision enters into force on the day of signing.

On the authority of the Rector

of the Military University of Technology

Piotr Zalewski, PhD, Eng., Prof. WAT
Director of the Doctoral School
Military University of Technology
/ **document signed with a qualified electronic signature** /

Prepared by: Dariusz Podbielski (SDR)
 Tel. 261837561, e-mail: dariusz.podbielski@wat.edu.pl

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology

No. 5/SDR/2021 of 8 April 2021

on the determination of the template of the mid-term report of a doctoral student and the interim opinion of the supervisor prepared before the mid-term evaluationof doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 6(5)(11) of the Organizational Regulations of the WAT Doctoral School, which is an annex to the Ordinance No. 48/RKR/2019 of the Rector of WAT of 28 November 2019 on the granting of the Organizational Regulations of Doctoral School of the Military University of Technology, in connection with § 14(1)(2) and § 29 of the Regulations of the Doctoral School of the Military University of Technology, constituting an annex to Resolution No. 49/WAT/2019 of the WAT Senate of 27 June 2019 2019 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following is introduced:
   1) a template of the interim report on the implementation of the Individual Research Plan, constituting Annex No. 1 to the decision,
   2) Template of the supervisor's mid-term opinion, constituting Annex No. 2 to the decision.

§ 2

1. The doctoral student submits the interim report in paper or electronic form to the supervisor and to the Dean's Office of the Doctoral School at least 14 days before the date of the mid-term evaluation.
2. The supervisor submits the opinion, in paper or electronic form, to the Dean's Office of the Doctoral School at least 7 days before the date of the mid-term evaluation.

§ 3

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the Doctoral School of the Military University of Technology No. 8/SDR/2021
of 8 April 2021

Wojskowa Akademia Techniczna

Szkoła Doktorska SDR

Warsaw, d.....

INTERIM REPORT
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE UNIVERSITY OF TECHNOLOGY

A. Information data

1. **Name and surname of the PhD student**

2. **Scientific discipline**

3. **Title/degree, name of the supervisor(s)**

4. **Title/degree, name and surname of the assistant supervisor**

5. **Topic of the doctoral dissertation**

B. Individual Research Plan (IPB)

1. **Preparation of the doctoral dissertation**
   1) **Information on issues related to the preparation of the doctoral dissertation completed in the first and second semester**

2) Issues planned to be implemented in the third and fourth semesters included in the IPB

Lp.	Stages of the doctoral dissertation and the issues pursued	Share in the total dissertation (%)	Implementation semester
1			III
2			IV

3) IPB implementation

a) Information on the completed issues planned for the third and fourth semester of education

b) Information on failure to complete the issues planned for the third and fourth semester of education or failure to meet the assumed percentage share - reasons and planned date of implementation

c) Information on the status of IPB implementation – preparation of the doctoral dissertation

Lp.	IPB implementation semester	Completed share in the total dissertation (%)	Planned participation in the entire dissertation according to IPB (%)
1	III		
2	IV		
3	V-VIII*		

** enter how many % of the share in the total dissertation planned for the V-VIII semester was realized in semesters III-IV*

d) Information on the completion of issues planned for the V-VIII semester of education or other additional issues not included in the IPB

Issues covered by the IPB *Additional Considerations*

2. **Scientific activity since the beginning of education at the Doctoral School of the Military University of Technology**

   1) **Publications** *(authors, name of publication, publisher, ISBN number, date of publication or submission for publication, number of points from the list of the Ministry of Science and Higher Education)*

– –

   2) **Completed presentations at national or international scientific conferences** *(name of the conference, form of the conference, form of presentation, date)*

– –

   3) **Participation in the organization of national or international scientific conferences** *(name of the conference, form of organization, date)*

   4) **Implementation of a research internship or study trip to a domestic or foreign university or scientific institution** *(type of trip, name of the university or host institution, place, date)*

3. **Participation in projects, grants, programs**

Lp.	Name of the project, grant, program	Time of participation from- to	Institution financing /host /implementing	The role and participation of the doctoral student
1.				

4. **Additional information on achievements during the reporting period** *(e.g. awards, distinctions, etc.)*

……

Date and legible signature of the doctoral student

Attachments:

1. Appendix no. 1 – copy of the first page of the publication and abstract

Appendix No. 2 to the decision
Director of the Doctoral School of the Military University of Technology No. .../SDR/2021
of 2021

Warsaw, d.....

MID-TERM OPINION
PROMOTER[1]

1. **Name and surname of the doctoral student**

2. **Title/degree, name and surname of the supervisor**

3. **Supervisor's opinion on the implementation of an individual research plan by the doctoral student and assessment of the prospect of timely preparation of the doctoral dissertation by the doctoral student**

……
Date and signature of the supervisor(s)

[1] In the case of two or more supervisors, each supervisor prepares a separate opinion

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
No. 11/SDR/2022 of 12 April 2022

on the determination of the template of the mid-term report of a doctoral student and the interim opinion of the supervisor prepared before the mid-term evaluation of doctoral students of the Doctoral School of the Military University of Technology

Pursuant to § 103(6)(11) of the Statute of the Military University of Technology attached to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Jarosław Dąbrowski Military University of Technology (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in conjunction with § 28(4) of the Regulations of the Doctoral School of the Military University of Technology constituting an annex to the Resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Military University of Technology", it is decided as follows:

§ 1

1. The following is introduced:
   1) a template of the interim report on the implementation of the Individual Research Plan, constituting Annex No. 1 to the decision,
   2) Template of the supervisor's mid-term opinion, constituting Annex No. 2 to the decision.

§ 2

1. Subject to paragraph 2, the doctoral student shall, within the deadline specified in the academic year schedule, submit an interim report to the Dean's Office of the Doctoral School in paper or electronic form, together with the interim opinion of the supervisor(s).
2. A doctoral student who provides education at the Doctoral School as part of programmes, projects and contracts submits the interim report and the interim opinion of the supervisor or supervisors to the Dean's Office of the Doctoral School within the deadline specified by the Director of the Doctoral School.

§ 3

The Decision of the Director of the Jarosław Dąbrowski Military University of Technology Doctoral School No. 5/SDR/2021 of 8 April 2021 on the determination of the template of the mid-term report of a doctoral student and the interim opinion of the supervisor prepared before the mid-term evaluation of doctoral students of the Jarosław Dąbrowski Military University of Technology is hereby repealed.

§ 4

The decision enters into force on the day of signing.

Director
Doctoral School

Piotr ZALEWSKI, PhD, Eng., Prof. WAT

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the decision
Director of the WAT Doctoral School No. 11/SDR/2022
of 12 April 2022

Warsaw, d.....

INTERIM REPORT
DOCTORAL STUDENT AT THE DOCTORAL SCHOOL OF THE MILITARTY UNIVERSITY OF TECHNOLOGY

A. Information data

1. **Name and surname of the doctoral student**

2. **Scientific discipline**

3. **Title/degree, name of the supervisor(s)**

4. **Title/degree, name and surname of the assistant supervisor**

5. **Topic of the doctoral dissertation**

6. **Planned form of the doctoral dissertation**

B. Individual Research Plan (IPB)

1. Preparation of the doctoral dissertation

1) **Information on issues related to the preparation of the doctoral dissertation completed in the first and second semester** *(max. 2000 characters without spaces)*

2) Issues planned to be implemented in the third and fourth semesters included in the IPB

Lp.	Stages of the doctoral dissertation and the issues pursued	Implementation semester
1		III
2		IV

3) IPB implementation

a) Information on the planned for the third semester of education and completed issues – description of the implementation and results *(max. 2500 characters without spaces)*

b) **Information on the issues planned for the fourth semester of education and completed issues – description of the implementation and results, as well as information on the implementation of unrealized issues planned for the third semester** *(max. 2500 characters without spaces)*

c) **Information on the issues planned for the third and fourth semester of education,**
but not completed or failure to meet the assumed percentage share for these semesters - reasons and planned deadline for implementation *(max. 2000 characters without spaces)*

d) **Information on the status of the preparation of the doctoral dissertation - IPB implementation**

Lp.	IPB implementation semester	Completed share in the total dissertation (%)	Planned participation in the entire dissertation according to IPB (%)
1	I-II		
1	III		
2	IV		
3	Total		

e) **Information on additional completion of issues planned for the V-VIII semester of education or other additional issues not included in the IPB** *(max. 2000 characters without spaces)*

Issues covered by the IPB

Additional Considerations

2. Scientific activity since the beginning of education at the Doctoral School of the Military University of Technology[1]

1) Publications *(authors, name of publication, publisher, ISBN number, date of publication or submission for publication, number of points from the lists referred to in Article 267(3) of the Act of 20 July 2018 Law on Higher Education and Science, if the publication is included in the list)*

2) Completed presentations at national or international scientific conferences *(name of the conference, form of the conference, form of presentation, date)*

3) Participation in the organization of national or international scientific conferences *(name of the conference, form of organization, date)*

4) Implementation of a research internship or study trip to a domestic or foreign university or scientific institution *(type of trip, name of the university or host institution, place, date)*

5) Information on planned but not realized scientific activity projects – reference to points 1-4

[1] The doctoral student's scientific activity should be documented: in the case of publication, a copy of the first page and an abstract or a short abstract (in case of waiting for publication), the conference program, certificate, diploma, etc.

6) Participation in projects, grants, programs

Lp.	Name of the project, grant, program	Time of participation from- to	Institution financing /host /implementing	The role and participation of the doctoral student
1.				

7) Additional information on achievements during the reporting period *(e.g. awards, distinctions, etc.)*

……

date and legible signature of the doctoral student

Attachments *(documents confirming scientific activity):*

1. …….
2. …….

Appendix No. 2 to the decision
Director of the WAT Doctoral School No. 11/SDR/2022
of 12 April 2022

Warsaw, d.....

MID-TERM OPINION
PROMOTER[2]

1. **Name and surname of the doctoral student**

2. **Title/degree, name and surname of the supervisor**

3. **Evaluation of the implementation of an individual research plan by a doctoral student**

Positive/negative[3]

4. **Opinion on the implementation of an individual research plan by a doctoral student (justification of the assessment) [4]**

[2] In the case of two or more supervisors, each supervisor prepares a separate opinion
[3] delete unnecessary
[4] assessment of the timeliness, quality and compliance (substantive and percentage) of the implementation of the stages of preparation of the doctoral dissertation planned at IPB and the planned scientific activity of the doctoral student

5. **Information on the reasons for the delay in the implementation of the individual research plan[5]**

6. **Assessment of the state of preparation of the doctoral dissertation (in %) and the prospects of timely preparation of the doctoral dissertation by the doctoral student**

……

date and signature of the promoter

[5] including additional activity of the doctoral student, scientific achievements, participation in projects, grants, programs affecting the degree of IPB implementation

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
Jarosław Dąbrowski

No 5/SDR/2023 of 15 March 2023

on the determination of the template of the mid-term report of the doctoral student, the mid-term opinion of the supervisor and the mid-term opinion of the assistant supervisor prepared before the mid-term evaluation of doctoral students of the Doctoral School of the Military University of Technology Jarosław Dąbrowski

Pursuant to § 103 sec. 6 point 11 of the Statute of the Military University of Technology Jarosław Dąbrowski constituting an appendix to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology of Jarosław Dąbrowski (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 28 sec. 4 of the Regulations of the Doctoral School of the Military University of Technology of Jarosław Dąbrowski constituting an attachment to the resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology", the following is resolved:

§ 1

1. The following are introduced:
   1) template of the interim report on the implementation of the Individual Research Plan, constituting Appendix 1 to the decision,
   2) template of the supervisor's mid-term opinion, constituting Appendix No. 2 to the decision,
   3) template of the mid-term opinion of the assistant supervisor, constituting Appendix No. 3 to the decision.

§ 2

1. Subject to paragraph 2, the doctoral student, within the deadline specified in the schedule of the academic year, submits a mid-term report in paper and electronic form to the Dean's Office of the Doctoral School together with the mid-term opinion of the supervisor or supervisors.
2. A doctoral student pursuing education at the Doctoral School under the program entitled "Implementation Doctorate" submits a mid-term report in paper and electronic form to the Dean's Office of the Doctoral School, together with the mid-term opinion of the supervisor and the opinion of the assistant supervisor, within the deadline specified by the Director of the Doctoral School.

§ 3

The Decision of the Director of the Doctoral School of the Jarosław Dąbrowski Military University of Technology No. 11/SDR/2022 of 12 April 2022 on the determination of the template of the doctoral student's mid-term report and the supervisor's mid-term opinion prepared before the mid-term evaluation of doctoral students of the Doctoral School of the Jarosław Dąbrowski Military University of Technology is repealed.

§ 4

The decision shall enter into force on the date of signing.

Manager
Doctoral School of the Military
University of Technology

Piotr ZALEWSKI, PhD, Eng., Associate Professor

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the Decision
of the Director of the Doctoral School of the Military University of Technology No. 5/SDR/2023
of 15 March 2023

MID-TERM REPORT
DOCTORAL STUDENT OF THE WAT DOCTORAL SCHOOL

A. Informational data

1. **Name and surname of the doctoral student**

2. **Scientific discipline**

3. **Academic title/degree, name and surname of the supervisor(s)**

4. **Academic title/degree, name and surname of the assistant supervisor**

5. **Topic of the doctoral dissertation**

6. **Planned form of the doctoral dissertation**

B. Individual Research Plan (IPB)

1. **Preparation of a doctoral dissertation**
   1) **Information on issues related to the preparation of the doctoral dissertation completed in the first and second semester** *(max. 2000 characters without spaces)*

   2) **Issues covered by the IRP planned to be implemented in the third and fourth semester**

Lp.	Stages of the doctoral dissertation and issues to be addressed	Implementation semester
1		III
2		IV

   3) **Implementation of the IPB**
      a) **Information on the issues planned for the third semester of education and completed – description of implementation and results** *(max. 2500 characters without spaces)*

      b) **Information on the issues planned for the fourth semester of education and completed – description of the implementation and results as well as information on the implementation of uncompleted issues planned for the third semester** *(max. 2500 characters without spaces)*

      c) **Information on unrealized issues planned for the third and fourth semester of education or failure to fulfill the assumed percentage share for these semesters - reasons and planned date of implementation** *(max. 2000 characters without spaces)*

d) Information on the status of the preparation of the doctoral dissertation - implementation of the IRP

Lp.	IPB implementation semester	Completed share in the entire dissertation (%)	Planned participation in the entire dissertation according to IPB (%)
1	I-II		
2	III		
3	IV		
4	Total as of 1 June		

e) Information on additional implementation of issues planned for the V-VIII semester of education or other additional issues not included in the IRP *(max. 2000 characters without spaces)*

Issues covered by the IRP

Additional considerations

2. Scientific activity since the beginning of education at the Doctoral School of the Military University of Technology[1]

1) Publications *(authors, name of the publication, publishing house, ISBN number, date of publication or submission for publication, number of points from the lists referred to in Article 267(3) of the Act of 20 July 2018 Law on Higher Education and Science, if the publication is included in the list)*

2) Presentations at national or international scientific conferences *(name of the conference, form of the conference, form of presentation, date)*

3) Participation in the organization of national or international scientific conferences *(name of the conference, form of organization, date)*

[1] The scientific activity of a doctoral student should be documented: in the case of publication, a copy of the first page and an abstract or a short abstract (if waiting for publication), conference program, certificate, diploma, etc.

4) **Implementation of a scientific internship or study trip to a domestic or foreign university or research institution** *(type of mobility, name of the host university or institution, place, date)*

5) **Information on planned but unimplemented projects of scientific activity – reference to points 1-4**

6) **Participation in projects, grants, programs**

Lp.	Name of the project, grant, program	Participation time from- to	Institution financing company /host /implementing	Role and participation of a doctoral student
1.				

7) **Additional information about achievements during the reporting period** *(e.g. awards, distinctions, etc.)*

……

date and legible signature of the doctoral student

Appendices *(documents confirming scientific activity):*

1. …….
2. …….

Wojskowa Akademia Techniczna

Szkoła Doktorska SDR

MID-TERM OPINION
PROMOTER[2]

1. **Name and surname of the doctoral student**

2. **Academic title/degree, name and surname of the supervisor**

3. **Evaluation of the implementation of the individual research plan by the doctoral student**

Positive/Negative[3]

4. **Opinion on the implementation of an individual research plan by a PhD student (justification of the assessment) [4]**

[2] In the case of two or more supervisors, each supervisor prepares a separate opinion

[3] delete as necessary

[4] assessment of the timeliness, quality and compliance (substantive and percentage) of the implementation of the stages of preparation of the doctoral dissertation planned at the IRP and the planned scientific activity of the doctoral student

5. **Information on the reasons for delays in the implementation of the individual research plan, if any.**[5]

6. **Assessment of the state of preparation of the doctoral dissertation (in %) and the prospects for timely preparation of the doctoral dissertation by the doctoral student**

……

date and signature of the supervisor

[5] including additional activity of the doctoral student, scientific achievements, participation in projects, grants, programs affecting the degree of implementation of the IRP

Appendix No. 3 to the Decision
of the Director of the Doctoral School of the Military University of Technology No. 5/SDR/2023
of 15 March 2023

MID-TERM OPINION
AUXILIARY SUPERVISOR[6]

1. **Name and surname of the doctoral student**

2. **Title/degree of study/incl. name and surname of the assistant supervisor**

3. **Evaluation of the implementation of the individual research plan by the doctoral student**

   Positive/Negative[7]

4. **Opinion on the implementation of an individual research plan by a PhD student (justification of the assessment)[8]**

5. **Assessment of the state of preparation of the doctoral dissertation (in %) and the prospects for timely preparation of the doctoral dissertation by the doctoral student**

.....

date and signature of the assistant supervisor

[6] only for doctoral students pursuing education under the program entitled "Implementation doctorate"
[7] delete as necessary
[8] assessment of the timeliness, quality and compliance (substantive and percentage) of the implementation of the stages of preparation of the doctoral dissertation planned at the IRP and the planned scientific activity of the doctoral student, as well as information on the possible reasons for the delay in the implementation of the IRP

Wojskowa Akademia Techniczna

Decision
Director of the Doctoral School
Military University of Technology
Jarosław Dąbrowski

No 5/SDR/2023 of 15 March 2023

on the determination of the template of the mid-term report of the doctoral student, the mid-term opinion of the supervisor and the mid-term opinion of the assistant supervisor prepared before the mid-term evaluation of doctoral students of the Doctoral School of the Military University of Technology Jarosław Dąbrowski

Pursuant to § 103 sec. 6 point 11 of the Statute of the Military University of Technology Jarosław Dąbrowski constituting an appendix to the Resolution of the Senate of the Military University of Technology No. 16/WAT/2019 of 25 April 2019 on the adoption of the Statute of the Military University of Technology of Jarosław Dąbrowski (i.e. Announcement of the Rector of the Military University of Technology No. 1/WAT/2021 of 21 October 2021), in connection with § 28 sec. 4 of the Regulations of the Doctoral School of the Military University of Technology of Jarosław Dąbrowski constituting an attachment to the resolution No. 21/WAT/2021 of the Senate of the Military University of Technology of 29 April 2021 on the adoption of the "Regulations of the Doctoral School of the Jarosław Dąbrowski Military University of Technology", the following is resolved:

§ 1

1. The following are introduced:
   1) template of the interim report on the implementation of the Individual Research Plan, constituting Appendix 1 to the decision,
   2) template of the supervisor's mid-term opinion, constituting Appendix No. 2 to the decision,
   3) template of the mid-term opinion of the assistant supervisor, constituting Appendix No. 3 to the decision.

§ 2

1. Subject to paragraph 2, the doctoral student, within the deadline specified in the schedule of the academic year, submits a mid-term report in paper and electronic form to the Dean's Office of the Doctoral School together with the mid-term opinion of the supervisor or supervisors.
2. A doctoral student pursuing education at the Doctoral School under the program entitled "Implementation Doctorate" submits a mid-term report in paper and electronic form to the Dean's Office of the Doctoral School, together with the mid-term opinion of the supervisor and the opinion of the assistant supervisor, within the deadline specified by the Director of the Doctoral School.

§ 3

The Decision of the Director of the Doctoral School of the Jarosław Dąbrowski Military University of Technology No. 11/SDR/2022 of 12 April 2022 on the determination of the template of the doctoral student's mid-term report and the supervisor's mid-term opinion prepared before the mid-term evaluation of doctoral students of the Doctoral School of the Jarosław Dąbrowski Military University of Technology is repealed.

§ 4

The decision shall enter into force on the date of signing.

Manager
Doctoral School of the Military
University of Technology

Piotr ZALEWSKI, PhD, Eng., Associate Professor

Prepared by: Dariusz Podbielski – SDR WAT

Appendix No. 1 to the Decision
of the Director of the Doctoral School of the Military University of Technology No. 5/SDR/2023
of 15 March 2023

MID-TERM REPORT
DOCTORAL STUDENT OF THE WAT DOCTORAL SCHOOL

A. Informational data

1. **Name and surname of the doctoral student**

2. **Scientific discipline**

3. **Academic title/degree, name and surname of the supervisor(s)**

4. **Academic title/degree, name and surname of the assistant supervisor**

5. **Topic of the doctoral dissertation**

6. **Planned form of the doctoral dissertation**

B. Individual Research Plan (IPB)

1. **Preparation of a doctoral dissertation**
   1) **Information on issues related to the preparation of the doctoral dissertation completed in the first and second semester** *(max. 2000 characters without spaces)*

   2) **Issues covered by the IRP planned to be implemented in the third and fourth semester**

Lp.	Stages of the doctoral dissertation and issues to be addressed	Implementation semester
1		III
2		IV

   3) **Implementation of the IPB**
      a) **Information on the issues planned for the third semester of education and completed – description of implementation and results** *(max. 2500 characters without spaces)*

      b) **Information on the issues planned for the fourth semester of education and completed – description of the implementation and results as well as information on the implementation of uncompleted issues planned for the third semester** *(max. 2500 characters without spaces)*

      c) **Information on unrealized issues planned for the third and fourth semester of education or failure to fulfill the assumed percentage share for these semesters - reasons and planned date of implementation** *(max. 2000 characters without spaces)*

d) Information on the status of the preparation of the doctoral dissertation - implementation of the IRP

Lp.	IPB implementation semester	Completed share in the entire dissertation (%)	Planned participation in the entire dissertation according to IPB (%)
1	I-II		
2	III		
3	IV		
4	Total as of 1 June		

e) Information on additional implementation of issues planned for the V-VIII semester of education or other additional issues not included in the IRP *(max. 2000 characters without spaces)*

Issues covered by the IRP

Additional considerations

2. Scientific activity since the beginning of education at the Doctoral School of the Military University of Technology[1]

1) Publications *(authors, name of the publication, publishing house, ISBN number, date of publication or submission for publication, number of points from the lists referred to in Article 267(3) of the Act of 20 July 2018 Law on Higher Education and Science, if the publication is included in the list)*

2) Presentations at national or international scientific conferences *(name of the conference, form of the conference, form of presentation, date)*

3) Participation in the organization of national or international scientific conferences *(name of the conference, form of organization, date)*

[1] The scientific activity of a doctoral student should be documented: in the case of publication, a copy of the first page and an abstract or a short abstract (if waiting for publication), conference program, certificate, diploma, etc.

4) **Implementation of a scientific internship or study trip to a domestic or foreign university or research institution** *(type of mobility, name of the host university or institution, place, date)*

5) **Information on planned but unimplemented projects of scientific activity – reference to points 1-4**

6) **Participation in projects, grants, programs**

Lp.	Name of the project, grant, program	Participation time from- to	Institution financing company /host /implementing	Role and participation of a doctoral student
1.				

7) **Additional information about achievements during the reporting period** *(e.g. awards, distinctions, etc.)*

……

date and legible signature of the doctoral student

Appendices *(documents confirming scientific activity):*

1. …….
2. …….

Wojskowa Akademia Techniczna

Szkoła Doktorska SDR

MID-TERM OPINION
PROMOTER[2]

1. **Name and surname of the doctoral student**

2. **Academic title/degree, name and surname of the supervisor**

3. **Evaluation of the implementation of the individual research plan by the doctoral student**

Positive/Negative[3]

4. **Opinion on the implementation of an individual research plan by a PhD student (justification of the assessment) [4]**

[2] In the case of two or more supervisors, each supervisor prepares a separate opinion

[3] delete as necessary

[4] assessment of the timeliness, quality and compliance (substantive and percentage) of the implementation of the stages of preparation of the doctoral dissertation planned at the IRP and the planned scientific activity of the doctoral student

5. **Information on the reasons for delays in the implementation of the individual research plan, if any.**[5]

6. **Assessment of the state of preparation of the doctoral dissertation (in %) and the prospects for timely preparation of the doctoral dissertation by the doctoral student**

……

date and signature of the supervisor

[5] including additional activity of the doctoral student, scientific achievements, participation in projects, grants, programs affecting the degree of implementation of the IRP

Appendix No. 3 to the Decision
of the Director of the Doctoral School of the Military University of Technology No. 5/SDR/2023
of 15 March 2023

MID-TERM OPINION
AUXILIARY SUPERVISOR[6]

1. **Name and surname of the doctoral student**

2. **Title/degree of study/incl. name and surname of the assistant supervisor**

3. **Evaluation of the implementation of the individual research plan by the doctoral student**

   Positive/Negative[7]

4. **Opinion on the implementation of an individual research plan by a PhD student (justification of the assessment)[8]**

5. **Assessment of the state of preparation of the doctoral dissertation (in %) and the prospects for timely preparation of the doctoral dissertation by the doctoral student**

.....

date and signature of the assistant supervisor

[6] only for doctoral students pursuing education under the program entitled "Implementation doctorate"
[7] delete as necessary
[8] assessment of the timeliness, quality and compliance (substantive and percentage) of the implementation of the stages of preparation of the doctoral dissertation planned at the IRP and the planned scientific activity of the doctoral student, as well as information on the possible reasons for the delay in the implementation of the IRP

Wojskowa Akademia Techniczna

Nr sprawy: 322186

UPOWAŻNIENIE ADMINISTRACYJNE NR 207/RKR/U/2025
Rektora Wojskowej Akademii Technicznej
im. Jarosława Dąbrowskiego

z dnia 28 października 2025 r.

Panu dr. inż. Piotrowi ZALEWSKIEMU, prof. WAT – dyrektorowi Szkoły Doktorskiej WAT, legitymującemu się dowodem osobistym nr DHV 155224 wydanym przez Prezydenta m.st. Warszawy, na podstawie art. 23 ust. 1 i 2 ustawy z dnia 20 lipca 2018 r. – Prawo o szkolnictwie wyższym i nauce w zw. z art. 268a ustawy z dnia 14 czerwca 1960 r. – Kodeks postępowania administracyjnego, udzielam upoważnienia do reprezentowania Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego w zakresie ewaluacji Szkoły Doktorskiej WAT za lata 2019-2025, a w szczególności do:

1) złożenia w Systemie Ewaluacji Szkół Doktorskich (SEDOK) raportu samooceny, w tym dokumentów związanych z procesem kształcenia doktorantów i działalnością Szkoły Doktorskiej WAT,
2) podpisania raportu samooceny, uzupełnień do raportu samooceny, uwag do raportu i zastrzeżeń do oceny,
3) podpisania oświadczenia o zgodności zawartych w raporcie samooceny informacji w języku polskim i angielskim ze stanem faktycznym,
4) dokonywania czynności wskazanych w § 6 rozporządzenia Ministra Edukacji i Nauki z dnia 27 września 2021 r. w sprawie ewaluacji jakości kształcenia w szkole doktorskiej (Dz. U. z 2021 r. poz. 1847).

Upoważniony nie może cedować swoich uprawnień, wynikających z upoważnienia, na osoby trzecie, bez pisemnej zgody upoważniającego.

Upoważnienie obowiązuje do dnia 31 grudnia 2026 r.

Upoważnienie może być w każdym czasie odwołane przez upoważniającego.

Upoważnienie zostało udzielone w wersji elektronicznej.

gen. bryg. prof. dr hab. inż. Przemysław Wachulak
Rektor-Komendant
Wojskowa Akademia Techniczna
/ dokument podpisany kwalifikowanym podpisem elektronicznym /

KEN

2023-2027

NATIONAL INFORMATION PROCESSING INSTITUTE

Minister of Science and Higher Education
Republic of Poland

Assessment of the quality of education in doctoral schools
is made by the Science Evaluation Committee

The Evaluation System of Doctoral Schools
is financed by the Minister of Science and Higher Education