Załącznik
do Uchwały Senatu WAT Nr 153/WAT/2023
z dnia 30 listopada 2023 r.

(Appendix
to the Resolution of the WAT Senate No. 153/WAT/2023
November 30, 2023)

WOJSKOWA AKADEMIA TECHNICZNA
im. Jarosława Dąbrowskiego
(MILITARY UNIVERSITY OF TECHNOLOGY)

STUDY PROGRAMME

Level: Second-cycle studies

Field of study: **MECHANICAL ENGINEERING**
Profile of study: **GENERAL ACADEMIC**
Mode of study: **FULL-TIME**

Uchwała Senatu Wojskowej Akademii Technicznej
im. Jarosława Dąbrowskiego
nr 153/WAT/2023 z dnia 30 listopada 2023 r.

w sprawie ustalenia programu studiów drugiego stopnia dla kierunku studiów „Mechanika i budowa maszyn" prowadzonych w języku angielskim

(Resolution of the Senate the Jarosław Dąbrowski Military University of Technology
No. 153/WAT/2023 of November 30, 2023

authorizing the adoption of the second-cycle study programme
within the field of study "Mechanical Engineering" conducted in English)

Effective from the academic year 2023/2024

Warsaw

2023

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CURRICULUM
organizational assumptions

Field: MECHANICAL ENGINEERING

Level of study: **Second-cycle studies**

Profile of study: **General academic**

Mode of study: **Full-time**

Degree awarded to graduates: **Master of Engineering, M.Eng.**
(magister inżynier)

Polish Qualifications Framework Level: **7**

Classification of the field of study:

Field of science: **Engineering and Technology**
Scientific discipline: **Mechanical Engineering**

Language of study: **English**

No. of semesters: **3**

Total no. of hours: **840**

No. of ECTS credits required to complete the studies: 90 ECTS

Total no. of ECTS credits that students must earn in the course of the studies:

- **courses with direct participation of academic teachers or other instructors: 49 ECTS**
- **humanities or social sciences courses[1]: 7 ECTS**

Length, no. of ECTS credits, rules and form of internship:
No internship at the second-cycle level.

[1] *Not applicable to fields of study that fall into the disciplines of humanities or social sciences respectively.*

CHARACTERISTICS OF THE FIELD OF STUDY

"Mechanical engineering" field of study belongs to the engineering and technology field of science and scientific discipline of Mechanical Engineering. It is related to following fields of study: "automation and robotics", "bioeconomy", "power engineering", "materials engineering", "logistics", "mechatronics", "management and production engineering".

IMPLEMENTATION OF STUDIES

The Faculty of Mechanical Engineering of the Military University of Technology is responsible for conducting studies in the field of "mechanical engineering". The faculty has a modern and comprehensively equipped teaching and scientific base, ensuring the possibility of conducting teaching classes and scientific research at a high level.

Second-cycle studies last 1.5 years, cover 3 semesters, and finish with the award of the professional title of Master of Science in Engineering. In second-cycle studies, students obtain 90 ECTS points. The educational core of the study programme includes contents specific to the field of study "mechanical engineering".

The transparent structure of the study plans at the faculty enables the implementation of an individual course of study by each student. This program concept makes the profile of a graduate more complete in terms of content and enables much greater adaptability of graduates in their professional work than before.

PERSONAL AND PROFESSIONAL PROFILE OF THE GRADUATE

A graduate of second-cycle studies in the field of "mechanical engineering" has the knowledge and skills to independently carry out tasks and manage the work of teams involved in the structural and technological design of machine elements and assemblies, their production and operation. Elective subjects enable the student to deepen knowledge closely related to the chosen educational path. In addition, students acquire knowledge and skills enabling participation in scientific research in the discipline of mechanical engineering.

A graduate of the field of "mechanical engineering" is also prepared to work in military units as well as enterprises and research and development units subordinated to the Minister of National Defence (Poland), as civilian senior technical staff.

A graduate of second-cycle studies is prepared to continue education at a doctoral school and is ready to develop his/her professional skills as part of postgraduate studies and further training courses.

DESCRIPTION OF THE ASSUMED LEARNING OUTCOMES

The description of learning outcomes includes:

– universal first-cycle characteristics set out in the Appendix to the Act of 22 December 2015 on the Integrated Qualifications System
– second-cycle characteristics set out in the Appendix to the Regulation of Minister of Science and Higher Education of 14 November 2018 on the second-cycle characteristics of learning outcomes for level 6-8 qualifications of the Polish Qualifications Framework, including requirements for obtaining engineering qualifications[2]

and it comprises three categories:

– the **knowledge (W)** category which specifies:
  – size and depth **(G)** – completeness of the cognitive perspective and relationships,
  – context **(K)** – conditions, effects.
– the **skills (U)** category which specifies:
  – in terms of application of knowledge (**W**) – problems to be solved and tasks to be performed,
  – in terms of communication (**K**) – receiving and formulating statements, spreading knowledge in the scientific community and speaking a foreign language,
  – in terms of work organisation (**O**) – planning and teamwork,
  – in terms of learning (**U**) – planning own personal development and development of others.
– the **social competences (K)** category which specifies:
  – in terms of evaluations (**K**) – critical approach,
  – in terms of responsibility (**O**) – fulfilling civic duties and acting in the public interest,
  – in terms of professional role (**R**) – independence and formation of professional ethos.

Symbols:
– in the **Outcome symbol and number** column:
  – K – major-specific learning outcomes;
  – W, U, K (after underscore) – category: W for knowledge, U for skills, K for social competences;
  – 01, 02, 03, ... – no. of learning outcome.
– in the **Description component code** column: Inż[3]*_P7S_WG* – description component code for second-cycle characteristics for level 7 qualifications of the Polish Qualifications Framework.

[2] *Applicable to fields of study that finish with the award of the following degrees: Eng. (inż.), M.Eng. (mgr inż.)*
[3] *For engineering qualifications.*

Outcome symbol and number	Description of learning outcomes	Description component code
KNOWLEDGE	**Graduate:**	
K_W01	Has an advanced and deep knowledge of some branches of mathematics, in particular elements of discrete mathematics and applied mathematics and methods of optimization, including the mathematical methods necessary for: 1) describing the dynamics of complex mechanical systems, 2) designing and performing engineering calculations for complex mechanical systems based on numerical methods.	P7S_WG Inż_P7S_WG
K_W02	Has an advanced and deep knowledge of physics, in particular the basics of quantum physics and solid-state physics, including the knowledge necessary for understanding physical phenomena and solving complex problems in the area of mechanical engineering.	P7S_WG
K_W03	Has a deep theory-based knowledge of analytical mechanics.	P7S_WG
K_W04	Has a deep theory-based knowledge of modelling for supporting machinery design.	P7S_WG Inż_P7S_WG
K_W05	Has an advanced theory-based knowledge of modern engineering materials, trends in their development and the most important new advancements.	P7S_WG
K_W06	Has a deep theory-based knowledge of integrated manufacturing systems.	P7S_WG
K_W07	Has a structured, theory-based, and detailed knowledge of mechatronics and mechanical system modelling.	P7S_WG
K_W08	Has a deep knowledge and understanding of selected facts, structures and phenomena and the methods and theories that explain the relationships between them, representing an advanced knowledge of the area covered by elective courses.	P7S_WG Inż_P7S_WG
K_W09	Has a knowledge and understanding of standard engineering technologies, is familiar with the current state and main trends in the development of mechanical engineering.	P7S_WG
K_W10	Has a deep knowledge and understanding of the methods, techniques, tools and materials used to solve complex engineering problems in the area of mechanical engineering.	P7S_WG
K_W11	Has a knowledge and understanding of the dilemmas faced by modern society – including problems of limitations specific to various disabilities – concepts and principles of environmental protection, industrial property protection, copyright, intellectual property management and knows how to use patent information.	P7S_WK
K_W12	Has a knowledge and understanding of the basic principles of creating and developing various forms of business (including a sole proprietorship), including risk analysis based on the knowledge of mechanical engineering.	P7S_WK Inż_P7S_WK
K_W13	Has a deep knowledge and understanding of the multidisciplinary nature of engineering and technical sciences, understands the place and role of social sciences and humanities and their relationship to engineering and technical sciences.	P7S_WG
K_W14	Has a knowledge and understanding of the life cycle of technical equipment, structures and systems used in mechanical engineering.	Inż_P7S_WG
K_W15	Has a knowledge and understanding of the economic, legal, and ethical issues associated with the work of a mechanical engineer and knows the basic principles of occupational health and safety.	P7S_WK
K_W16	Has an advanced and in-depth knowledge of the principles of universal design, in particular knowing and understanding people's limitations due to their disabilities and identifying barriers created by objects and technical systems in relation to these people.	P7S_WK Inż_P7S_WK
K_W17	Has a knowledge of the principles, methods, and regulations of goods movement (including hazardous materials) by various means of transport, and understanding of logistics, the role of transport in the supply chain and the impact on global trade.	P7S_WG

Outcome symbol and number	Description of learning outcomes	Description component code
SKILLS	**Graduate:**	
K_U01	Is able to put knowledge into practice – formulate and solve complex and atypical problems in the area of mechanical engineering through careful selection of sources and information contained in them, evaluate them, perform a critical analysis and synthesis of such information.	Inż_P7S_UW
K_U02	Is able to communicate about specialist topics using various methods (oral, written, visual, technical, teamwork methods) within various circles and get actively involved in national and international communities.	P7S_UK
K_U03	Is able to hold a debate about mechanical engineering issues in order to spread knowledge within the scientific community and discuss ideas and problems in the professional, non-professional and international circles.	P7S_UK
K_U04	Is able to perform mechanics and machinery construction tasks in an innovative way in unpredictable conditions through creative interpretation of information and presentation of solutions.	P7S_UK
K_U05	Is able to independently plan and implement lifelong learning, e.g. by improving professional qualifications and personal skills, and to provide others with guidance in that area.	P7S_UU
K_U06	Speaks a foreign language at B2+ level according to the Common European Framework of Reference for Languages and uses specialist terminology.	P7S_UK
K_U07	Is able to choose the right mathematical methods, tools and models and use them and perform computer simulations for the purpose of solving complex and atypical problems related to the analysis and evaluation of the performance of machinery components.	Inż_P7S_UW
K_U08	Is able to plan and conduct experiments, including measurements of physical properties (e.g. mechanical and electrical properties) and computer simulations of the changes in the adopted variables, interpret results and draw conclusions.	Inż_P7S_UW
K_U09	Is able to apply analytical, simulation and experimental methods for the purpose of identifying and formulating specifications of engineering problems in the area of mechanical engineering (structures, processes, and systems) and solving them.	Inż_P7S_UW
K_U10	Is able to recognize systemic and non-technical aspects, including social, health, ethical, environmental, economic, and legal aspects, when identifying and formulating specifications of complex and unconventional engineering problems and solving them.	Inż_P7S_UW
K_U11	Is able to analyse signals and simple signal processing systems with analogue and digital techniques and appropriate hardware and software tools.	P7S_UW
K_U12	Is able to compare design solutions used in mechanical and mechatronic systems according to adopted performance criteria.	P7S_UW
K_U13	Is able to use appropriate methods and equipment for measuring basic parameters of mechanical elements and systems.	P7S_UW
K_U14	Is able to design the testing process for machinery components and simple mechanical systems and – in the case of errors – diagnose them.	P7S_UW
K_U15	Is able to use index cards, product standards and application notes to select appropriate components for the designed mechanical equipment or systems.	Inż_P7S_UW
K_U16	Is able to design – following the specifications – and execute a standard simple device, structure, system or carry out a process in a mechanical system by using appropriate methods, techniques, tools, and materials.	Inż_P7S_UW
K_U17	Is able to formulate and test hypotheses associated with simple research problems related to the design of elements, systems, and machinery.	P7S_UW
K_U18	Is able to determine the usefulness and applicability of new advances (techniques and technologies) in machinery design, construction, production, and operation.	P7S_UW

Outcome symbol and number	Description of learning outcomes	Description component code
K_U19	Is able to apply the acquired knowledge within industrial businesses and other businesses engaged in production activities, operation, design, and research, and is able to apply the principles of occupational health and safety relative to such work.	P7S_UW
K_U20	Is able to critically evaluate the performance of existing technical solutions, in particular, equipment, structures, systems, processes and services.	Inż_P7S_UW
K_U21	Is able to suggest improvements (upgrades) to existing technical solutions in terms of mechanical engineering, also by using patent information.	P7S_UW
K_U22	Is able to manage the safe road transport, including route planning, emergency preparedness, accident response, considering technological innovations in transport.	P7S_UW
K_U23	Is able to evaluate the usefulness of methods and tools designed to solve complex engineering problems, including atypical elements and simple research problems, characteristic of mechanical engineering, and to recognise the limitations of such methods and tools.	P7S_UW
K_U24	Is able to design – following the required specifications and considering non-technical aspects, including the principles of universal design – a complex device, structure, system, or process related to mechanical engineering, and to implement the design – at least in part – by using appropriate methods, techniques, and tools, also by adapting any existing or developing new tools.	P7S_UW
K_U25	Is able to direct a team while working on a problem, engage in teamwork and assume the role of leader (moderator) of a team, is aware of the responsibility for own work and ready to obey the rules of teamwork and to accept responsibility for joint work.	P7S_UO
K_U26	Is able to identify and interpret basic social, humanistic, and legal phenomena and processes relative to mechanical engineering.	P7S_UW
K_U27	Is able to perform a preliminary economic assessment of proposed solutions and conducted engineering operations for the purpose of identifying and formulating specifications of engineering problems and solving them.	P7S_UW Inż_P7S_UW
K_U28	Is able to critically evaluate and define basic technical barriers, as well as design – based on available methods and tools – a technical solution that considers the needs of people with various limitations.	Inż_P7S_UW
SOCIAL COMPETENCES	**Graduate:**	
K_K01	Is prepared to perform a critical assessment of acquired information and recognizes the role of knowledge in solving cognitive and practical problems and the importance of consulting experts if there is a problem that cannot be solved single-handedly.	P7S_KK
K_K02	Is prepared to fulfil his/her civic duties, inspire, and organize initiatives for the benefit of the community and initiate actions serving the public interest, has an entrepreneurial mindset.	P7S_KO
K_K03	Is prepared to fulfil professional roles taking into consideration changing social needs, in particular contribute to the profession's output, maintain its ethos, obey, and develop principles of professional ethics and promote the compliance with such principles.	P7S_KR

LIST OF SUBJECTS

Subject groups / subjects[4], their brief description (framework programmes), assigned ECTS credits and learning outcomes (reference to the field-specific outcomes)

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
	General education General subjects			
1.	***FOREIGN LANGUAGE*** *Language / style / academic vocabulary of B2+ level. Grammar consolidation for academic reading, listening, speaking, and writing; reading and understanding technical texts (definitions, abstracts, scientific publications, articles etc.). The art of oral presentation.*	**2**	J	K_U02 K_U03 K_U06 K_K01
2.	***COMMUNICATION AND FUNDAMENTALS OF NEGOTIATION*** *Conflict sources and resolution. The process, types, and functions of communication. The essence and types of negotiation. Negotiation strategies, styles, and tactics. Personality traits of negotiators. Common negotiation mistakes. Communication in negotiation. Negotiation in practice.*	**2.5**	NKSM	K_W13 K_U25 K_K01
3.	***SELECTED TOPICS IN PSYCHOLOGY*** *The subject of psychology. Attitudes and their change. Emotions as a determinant of human behaviour. Stress in human life. Personality determinants of human functioning. Social conflicts and the methods of solving them. Self-presentation and the first impression. Motivating people to activity and self-motivating.*	**2.5**	P	K_W13 K_U26 K_K01
4.	***OCCUPATIONAL HEALTH AND SAFETY*** *Current OHS legislation. Occupational (educational) health and safety – safety procedures required in a specific job (activity) according to scientific and technical rationale. Protection from hazards to students' health and safety. Use of personal protective equipment in class (tutorials). Accident insurance. Procedures to be followed in case of accidents and in hazardous situations. Premedical first aid training.*	**0**		K_W15 K_U19 K_K01
	Core Education Core Subjects			
1.	***ANALYTICAL MECHANICS*** *Constraints. Generalised coordinates, velocities and acceleration. Virtual displacements. Virtual work. Virtual work principle. D'Alembert's principle. Lagrange's equations type 1 and 2. Lagrange's equations in Cartesian coordinates. Relationship between generalised coordinates and Cartesian coordinates. Generalised forces. Generalised momentum. Kinetic and potential energy. Lagrange's function in generalised coordinates. Hamilton's principle. Minor oscillations of systems with one or two degrees of freedom. Rigid body dynamics.*	**2.5**	IM	K_W03 K_U09 K_K01 K_K03

[4] *Subject information sheets are prepared and made available 30 days before the start of the semester in which the subject is to be taught.*

[5] *Names of subject groups / subjects*

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
2.	***INNOVATION AND ENTREPRENEURSHIP*** *Innovation – definition and classification, innovation process, models of innovation creation, trends in innovative activities. Innovative enterprises (including start-ups) – concept and conditions of functioning and designing. Internal and external determinants of innovation. Sources of innovation and barriers to innovation implementation. Management focused on employee development – as the basis for innovation processes and shaping creativity. Intellectual capital in innovation processes. Building an innovation strategy for an organization. Marketing and innovation. Finance analysis of innovation activities, as well as risk management in innovation processes and start-ups. Commercialization and technology transfer in an innovative enterprise. Innovation support systems on a national and regional scale. Social and economic effects of innovation.*	**2**	NZJ	K_W12 K_U27 K_K02
	Core Education **Core Subjects – Elective**			
3.	***COMPUTER TECHNIQUES IN STRUCTURAL ANALYSIS*** *The finite element method in structural analysis. Development and verification of numerical models of engineering structures. Physical and geometric nonlinearities in computational models. Models of a material. The issue of contact. Numerical analysis of selected FEM structures. Using specialist systems for nonlinear analysis with Hyperworks/Optistruct. Measurement and analysis of displacements, deformations, and stress in a structure in terms of elasticity and plasticity. Model development, calculations and analysis of results.*	**2**	IM	K_W04 K_W09 K_U07 K_U17 K_K01
4.	***EXPERIMENTAL TECHNIQUES IN STRUCTURAL ANALYSIS*** *Overview of the hardware and software used in experimental research. Basic research into isotropic and anisotropic materials under static loads. Impact testing of structures, thermal phenomena in impact testing. Cyclic loading, fatigue testing.*		IM	K_W02 K_W09 K_U08 K_U09 K_U11 K_U13 K_U17 K_K01
	Field-specific education **Field-specific subjects**			
1.	***INTRODUCTION TO DIGITAL MEASUREMENTS*** *Types of basic measuring transducers and their applications. Properties of measuring transducers. Construction of the measuring track. Introduction to LabView. Building a simple measurement application. Types of basic measurement signals and their properties. Continuous and discrete signals. The stages of digital processing of the measurement signal. Sinusoidal signal. Signal spectral analysis. Filtering the measurement signal. Evaluation of the degree of signal disturbance. Building a complex measurement application with the option of saving measurement data to a file. Processing of measurement data in Excel and Matlab environment. Automation of data processing and estimation of measurement uncertainty. Automation of charting. Inference in the correctness of the obtained measurement data.*	**2.5**	IM	K_W08 K_W13 K_U01 K_U03 K_U08 K_U11 K_K01
2.	***INTRODUCTION TO ELASTICITY AND PLASTICITY THEORY*** *Review of the linear algebra, tensor calculus and classical field theory. Fundamentals of the theory of elasticity, deformation state and stress state, material modelling, equations of*	**3**	IM	K_W01 K_W08 K_U01 K_U05 K_U06

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
	the theory of elasticity, solutions of the selected problems. Fundamentals of the theory of plasticity. Plastic potential, law of the plastic flow, plastic stability conditions.			K_U09 K_K01
3.	***MODERN ENGINEERING MATERIALS*** *Fundamental relationships between the structure and properties of modern engineering materials. Phase equilibrium systems. Methods of strengthening engineering materials. Modern structural steels. Selected non-ferrous metal alloys. Multifunctional materials. Ceramic materials, sinters, composites. Non-destructive and corrosion testing of engineering materials.*	**2.5**	IM	K_W05 K_W10 K_U05 K_U18 K_K01
4.	***AUTOMATICS AND ROBOTICS*** *General information about automatics and robotics. Methods of modelling of linear/non-linear elements and systems. Static and dynamic properties of elements and systems. Classic control systems and their elements. Analysis of control systems in time/frequency domain. Modern control systems. Automatics for complex systems and processes. Example applications of control systems and automatics. Robots and manipulators – general description*	**2.5**	IM	K_W01 K_W02 K_U01 K_U13 K_K01
5.	***INTEGRATED MANUFACTURING SYSTEMS*** *Development trends of material subtractive processes, CNC machine tools, monitoring and diagnostics of CNC machine tools, integration of manufacturing processes within single- and multi-machine tool systems, flow of materials and parts in manufacturing processes, Computer Aided Manufacturing (CAM) tools. Design of CNC subtractive manufacturing processes with CAD/CAM software.*	**2.5**	IM	K_W04 K_W06 K_U15 K_U18 K_K01
6.	***MACHINE DESIGN*** *The calculation of load capacity of gears according to ISO. Individual problems of machine design such as: Hertzian theory of contact problem, Euler's problem, Burzyński's hypothesis of stress invariants, design of machine elements depending on fatigue strength. Practical design of a hoist device with 3D structure modelling using CAD software.*	**4**	IM	K_W04 K_W14 K_U04 K_U09 K_U12 K_U15 K_U18 K_K01 K_K03
7.	***MACHINERY MODELLING AND SIMULATIONS*** *Principles of mechanical system modelling. Simplification of real systems, physical and mathematical models of a system. Kinematic and dynamic of the system. Kinetic and potential energy, and its dissipation. Lagrange vs d'Alembert methods in machinery modelling and simulations. Deterministic and random processes in mechanical systems. Preparation of mathematical model for numerical simulations using Laplace transform. Multibody method in machinery modelling and simulations – global and local coordinates systems, adding parts (geometry and mass properties), joints modelling (ideal and with friction), forces and torques modelling, flexible connections between parts (translational and rotational with linear and nonlinear characteristics), design variables and local measures.*	**4**	IM	K_W01 K_W04 K_U07 K_U09 K_K01
8.	***UNIVERSAL DESIGN IN MODELLING AND NUMERICAL ANALYSES*** *Characterization and presentation of the possibilities of using FEM modelling and numerical simulation and multi-body systems in the aspect of universal design issues. The issue of universal design, adaptation of vehicles and the use of*	**3.5**	IM	K_W09 K_W11 K_W16 K_U07 K_U10 K_U16

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
	equipment supporting the movement of people with special needs. Using analyses to assess the level of ergonomics and determining the impact of additional elements on the behaviour of their users. Analyses of multi-body systems in terms of adapting space for people with special needs. Designing a selected device/instrumentation for a vehicle and assessing its impact on a person's behaviour during a road incident using FEM simulations.			K_U21 K_U24 K_U28 K_K01 K_K02
	Elective Education Elective Subjects			
1.	***ENGINES OF MECHANICAL VEHICLES*** *Internal and external combustion engines. Engines parameters and characteristics. Engine performance parameters. Engine power. Engine efficiency. Engine heat balance. Parameters of air-fuel (A/F) ratio mixture. A/F mixture creation, and ignition and combustion. Stages of combustion and abnormal combustion – knocking. Fuel feeding in engines and dose correction. Governors function. Construction of mechanic and electronic governors. Air feeding of internal combustion engines. Engine charging. Induction and exhaust process in naturally-aspirated and forced inducted engines. Ecological problems of IC engine work. Toxic components exhaust gases. Assessment methods for toxic emissions. Catalysts and exhaust filters.*	**2.5**	IM	K_W07 K_W09 K_U01 K_U07 K_K01
2.	***HYBRID AND ELECTRIC PROPULSION SYSTEMS*** *Hybrid and electric propulsion systems – introduction. Hybrid vehicle parameters and characteristics. Electric engine parameters and characteristics. Fuel cells in vehicles. Hydrogen storage systems. Matching propulsion system to a vehicle. REESS and other Energy storage systems. Matching battery to a vehicle. Charging systems. Electrical infrastructure for electric vehicles. HV circuits. Ecological problems of alternative propulsion systems.*			
3.	***HYDRAULIC SYSTEMS FOR MOBILE APPLICATIONS*** *Basics of hydrostatics and hydrodynamics. Functional diagrams. Displacement pumps and motors – construction and characteristic. Hydraulic cylinders. Hydraulic fluids. Filtration. Design of power hydrostatic drives. Hydrostatic systems control. Centrifugal pumps and cooperation with pipelines. Hydrokinetic elements – construction and characteristic, criteria of choice.*	**3**	IM	K_W08 K_W13 K_W14 K_W16 K_U01 K_U16 K_U20 K_K01
4.	***THEORY OF LAND LOCOMOTION*** *Mechanics of tracks and pneumatic tires. Traction, grade and rolling resistance – motion limitation. Drivelines of vehicles. Construction and calculation of steering systems of tracked and wheeled vehicles. Vehicle stability. High mobility demand. Estimation of ground pressure and terrain mobility. Construction of wheeled and tracked gear systems. Gear system selection. Engine and transmission selection. Pulling power and efficiency. Stability of movement.*			
5.	***MECHANISMS MODELLING IN CATIA*** *Creating assembly models: description of structure, creating and modifying constraints. Quasi-kinematic analysis of assembly models. Creating kinematic models: adding component parts of a mechanism, simulating mechanism operation, measuring kinematic parameters. Modifying kinematic models and creating animations. Ergonomic analysis with consideration of the human model.*	**3**	IM	K_W04 K_U16 K_K01

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
6.	***PARTS DESIGN IN CATIA*** *Principles of working in the CATIA system. Sketcher functions. Part design. Surface design. Hybrid design. Formulas and parameters. Model analysis. Technical documentation.*			
7.	***COMPUTER-BASED FATIGUE CALCULATIONS*** *Introduction to fatigue of materials. S-N curve concept. Fatigue damage calculation. Mean stress corrections. Load spectra analysis. Low and high cycle fatigue. Computational technique in fatigue analysis.*	**2.5**	IM	K_W08 K_W10 K_W14 K_U01 K_K01
8.	***NUMERICAL MODELLING OF MATERIALS*** *Relationships between the materials structure in micro-scale and their macroscopic properties. Methods of numerical micro- and macro-scale modelling of modern materials. The material models of selected materials (foams, ceramics, elastomers) applied in commercial CAE software. Methods of materials testing and numerical models' verification. Development and analysis of the numerical models of selected structure.*			K_W01 K_W02 K_W05 K_W06 K_W10 K_U06 K_U07 K_U09 K_U12 K_U13 K_U21 K_K01
9.	***DEVICES FOR TRANSPORT AND DISTRIBUTION OF SERVICE FLUIDS*** *Characteristic of automotive, rail and pipeline transport of oil products. Regulations concerning devices for transport and distribution of service fluids. Construction and maintenance characteristics of railroad tank cars for the transport of fuels and oil products. Construction and maintenance characteristics of tank trucks for transport and distribution of fuels. Pipeline transport of crude oil and fuels. Characteristic of pumps used in devices for transport and distribution of service fluids. Characteristic of pumping assemblies. Characteristic of flowmeters, and nozzles used in devices for transport and distribution of service fluids. Maintenance of devices for transport and distribution of service fluids. Development tendencies of devices for transport and distribution of service fluids.*	**2.5**	IM	K_W08 K_W09 K_W10 K_U04 K_U10 K_U12 K_U14 K_U16 K_U18 K_U20 K_K01
10.	***FUNDAMENTALS OF TRIBOLOGY*** *Tribology in operation and maintenance of motor vehicles and transport devices. Tribological systems of motor vehicles and transport devices. Solids and liquids as construction elements of tribological systems. Processes of friction in tribological systems. Processes of tribological wear. Lubrication in tribological systems. Methods of investigations of friction and wear.*			K_W02 K_W13 K_U12 K_U14 K_U18 K_K01 K_K02
11.	***ENGINEERING SYSTEMS IN MOBILE APPLICATIONS*** *Mobile machines – basic definitions. Hydraulic systems, basic principles, and components. Design of engineering machines including unmanned ground vehicles. Basic analysis and calculations of design parameters and power transmission units. Human Machine Interfaces (HMIs). Development of engineering machines including unmanned ground vehicles and their systems. Prediction of off-road mobility of manned and unmanned ground platforms.*	**2.5**	IM	K_W08 K_U01 K_U02 K_U06 K_K01
12.	***PROGRAMMABLE CONTROL OF MECHATRONICS SYSTEMS*** *Components of mechatronic systems. Concepts of discrete control. Introduction to PLCs. The hardware configuration of PLCs. Communication in the PLC system. Representation of*			K_W13 K_U01 K_U11 K_K01

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
	input data. Graphical and textual programming languages basic functions, advantages, and disadvantages of the languages. Introduction to the CoDeSys.			
13.	***EXPERIMENTAL VEHICLE TESTING*** *Planning and organization of experimental vehicle research. Computer-aided experimental research. Signal acquisition systems and sensors for measuring mechanical quantities. Laboratory benches for testing selected vehicle systems and assemblies. Engine and chassis test benches. Road and field tests. Analysis of measurement results.*	**2**	IM	K_W08 K_W10 K_U08 K_U11 K_U13 K_U14 K_K01
14.	***MILITARY VEHICLE*** *Principles of designing modern military vehicles. Classification of vehicles in terms of their intended use. Overview of structural solutions of modern military vehicles – general structural layout. Basic features characterizing modern combat vehicles. Modularity of the construction of military vehicles. Construction of individual systems and subsystems of modern combat vehicles on the example of a tank, infantry fighting vehicle and armoured personnel carrier. Special equipment for military vehicles.*			K_W08 K_U01 K_U02 K_U03 K_U06 K_K01
15.	***FEM AND SIMULATION OF LINEAR PROBLEMS OF MECHANICS*** *Classification of linear problems of mechanics and methods for linear system analysis. Theoretical and computational aspects of finite element methods (FEM). Introduction to practical problems of linear FE analysis – typical algorithms of FE linear analysis. Examples from areas of linear elasticity, structural mechanics, and design of machine components. Basic relations in FE analysis of truss structures. Spring elements-stiffness matrices. 2D and 3D finite elements. Modelling of structure and boundary conditions, FE analysis and the interpretation of the results for 2D and 3D structures.*	**3**	IM	K_W01 K_W02 K_W04 K_U01 K_U07 K_U16 K_K01
16.	***MULTIBODY SIMULATION IN MECHANICAL ENGINEERING*** *Classification of multibody problems of mechanics and methods for multibody system simulation (MBB). Theoretical and computational aspects of multibody analysis. Introduction to multibody dynamics: differential-algebraic equations and system with constraints, numerical integrations. Basic concepts for multibody simulation-simulation of unconstrained/constrained mechanical systems. Modelling of multibody systems. Velocity and acceleration analysis in dynamic simulation. Introduction to practical problems of multibody analysis. MBB examples from areas of structural mechanics and design of machine components. Modelling of structure and boundary conditions, MBB analysis and the interpretation of the results for 2D and 3D structures.*			K_W01 K_W03 K_W10 K_U09 K_U10 K_U16 K_K01 K_K02
17.	***ASPECTS OF ROAD TRANSPORT OF HAZARDOUS MATERIALS*** *Selected legal and technical aspects of storage and road transport of hazardous substances in the EU. Types and characteristics of hazardous materials. Special marking and equipment of vehicles for the transport of dangerous substances. Principles of safe handling of hazardous substances in road transport. Hazardous transport exposure and methods of protection.*	**2**	IM	K_W08 K_W15 K_W17 K_U22 K_U26 K_K01

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
18.	***TRANSPORT OF GOODS*** *The fundamental principles of road transport, including the types of vehicles used for goods transportation, the regulatory framework that governs road transport of goods, and the principles of logistics management.*			
19.	***FUNDAMENTALS OF MECHANICAL VIBRATIONS*** *Fundamental concepts in vibration and modelling. Introduction to modelling and analysis. Harmonic motion. Free vibration of single degree of freedom systems. Forced harmonic excitation of single degree of freedom systems. The vibration of multi-degree of freedom systems. Eigenvalue problem. Resonance. Shaft vibration. Reduction of vibrations. Evaluation of human exposure to whole-body and hand-transmitted vibrations*			K_W01 K_W02 K_U01 K_U13 K_K01
20.	***TRANSPORT LOGISTICS*** *Characteristics of types of transportation (road, rail, transmission, water, air). Classification and transport susceptibility of cargo. Transportation exposures. Transportation packaging. Palletization and containerization of cargo. Restrictions Technical limitations in the transportation of cargo. Distribution centre management. Acquisition and transportation of goods. Warehouse management. Ways and risks of goods distribution. Identification of goods. Picking, packaging, and labelling of shipments. Optimization and rotation of inventory. Warehousing and distribution costs. Liability for unsold goods. Information technology base. Inventory of goods.*	**2**	IM	K_W08 K_W17 K_U22 K_U26 K_K01
21.	***HYBRID AND ELECTRIC VEHICLES MAINTENANCE AND SAFETY*** *Categories, types and construction of hybrid and electric vehicles. Construction of hybrid and electric powertrains of vehicles of different brands. Hazards and safe operation of hybrid and electric vehicles. Preparing electric and hybrid vehicle for service and diagnostics. Electrical HV safety during vehicle maintenance.*	**2.5**	IM	K_W09 K_W10 K_U09 K_U23 K_K01
22.	***REPAIR TECHNOLOGY OF VEHICLES*** *Principles of repair of modern vehicles. Selected repair technologies for components and assemblies of motor vehicles. Organization and equipment of technological workstations in automotive service companies. Technological process of repair. Logistics of service stations. Cost calculation in service activities.*			K_W09 K_W10 K_W14 K_U09 K_U23 K_K01
23.	***MODERN MEASUREMENT SYSTEMS*** *Overview of measurement concepts. Types and characteristics of sensors. Advanced sensor technologies and smart sensors. Fundamentals of signal conditioning. Advanced noise reduction and filtering techniques. Components of Data Acquisition Systems. Data logging and real-time data processing. IoT and big data in modern measurements.*	**1.5**	IM	K_W01 K_W07 K_W08 K_U01 K_U07 K_U11 K_U20
24.	***NAVIGATION AND POSITIONING SYSTEMS*** *Overview of navigation history and concepts. Basics of positioning. GNSS infrastructure and signal processing. Working principles of GPS. Differential GPS for improved accuracy. Principles of motion sensing. MEMS gyroscopes and accelerometers. Integration of INS with GNSS in navigation. Navigation in autonomous vehicles and drones. Positioning in complex environments, including GPS-denied environments.*			K_W07 K_W08 K_U01 K_U07 K_U11 K_U20

No.	Subject group Subject name[5]: brief description (framework programme)	No. of ECTS credits	Code of scientific discipline	Reference to field-specific outcomes
Thesis				
1.	**GRADUATION SEMINAR** *Faculty and university guidelines for the master thesis and the thesis defence. Students present the idea for their final project. Master thesis writing techniques. Avoiding plagiarism in Master thesis. Overview of visual communication techniques. Preparation for the thesis defence. Master thesis progress reporting.*	**2**	IM	K_W08 K_W11 K_U01 K_U02 K_U03 K_K01 K_K02 K_K03
2.	**THESIS** *Choosing a thesis topic. Analysis of an individual task and development of a schedule for the completion of the diploma thesis. Collecting literature for a diploma thesis. Development of a literature review and conclusions from this review. Completion of the diploma thesis appropriate to the type of work. Consulting progress with the supervisor. Preparation of the results in the form of text, charts, tables, and drawings, considering editorial standards and principles. Preparation of final conclusions from the work. Uploading the work to the USOS APD system. Preparing a presentation of the diploma thesis and preparing for the thesis defence. The thesis defence.*	**20**	IM	–
Total		**90**		

METHODS OF VERIFICATION AND ASSESSMENT OF LEARNING OUTCOMES[6] achieved by the student throughout the entire education cycle:

The achievement of learning outcomes is verified in class and through assessment of the student's performance in particular types of classes.

The verification covers learning outcomes achieved by the student through classes with direct participation of an academic teacher and students, practical classes (including practical classes, laboratories, seminars, and projects) as well as through individual learning and assignments completed by the student without the assistance of an academic teacher.

The verification of the learning outcomes takes the form of exams (written and oral), graded assessments, non-graded assessments, regular study progress control, tests, individual assignments, and field work.

The verification of the learning outcomes in terms of social competences is effected during tutorials, laboratory classes, seminars.

The assessment of learning outcomes achieved by the student involves an academic teacher evaluating the degree to which the student achieved the learning outcomes.

The Faculty of Mechanical Engineering advises the use of the following grading scale for assessment of the achieved learning outcomes:

Very good – grade awarded to students who achieved 91-100% of the learning outcomes.

Good plus – grade awarded to students who achieved 81-90% of the learning outcomes.

[6] *Overview only – for details see specific subject information sheets.*

Good	– grade awarded to students who achieved 71-80% of the learning outcomes.
Satisfactory plus	– grade awarded to students who achieved 61-70% of the learning outcomes.
Satisfactory	– grade awarded to students who achieved 51-60% of the learning outcomes.
Unsatisfactory	– grade awarded to students who achieved 50% of the learning outcomes or less.
PASS	– grade awarded to students who achieved more than 50% of the learning outcomes.
FAIL	– grade awarded to students who achieved 50% of the learning outcomes or less.

Class administration

The plan of studies specifies ("ONLINE" written in the Comments section) the subjects in the case of which selected class types (lectures, practical classes, laboratories, projects, seminars) can be administered by using methods and techniques of distance education based on infrastructure and software designed for synchronous and asynchronous interaction between students and course teachers.

Detailed information on the methods of administration of particular class types will be provided in the respective subject information sheets which are prepared and made available 30 days before the start of the semester in which the specific subject is to be taught.

The number of ECTS points that can be obtained as part of education using methods and techniques of distance learning is **2 ECTS**.

PLAN OF STUDIES

Appendix Plan of full-time second-cycle (master's) studies, general academic profile.

Military University of Technology

PLAN OF FULL-TIME SECOND-CYCLE (MASTER'S) STUDIES, GENERAL ACADEMIC PROFILE
(MAIN) DISCIPLINE OF SCIENCE: MECHANICAL ENGINEERING
FIELD OF STUDY: MECHANICAL ENGINEERING

effective from academic year 2023/2024 (summer)

	SUBJECT GROUPS / SUBJECTS	Total no. of hours / ECTS credits		including:					no. of hours/evaluations/ECTS credits per semester: I		II		III		organisational unit administering the course	Comments
		hours	ECTS	lecture	pract. classes	labor.	project	semin.	hours	ECTS	hours	ECTS	hours	ECTS		
A.	**General Subjects**	**94**	**7**	**36**	**58**				**94**	**7**						
1	Foreign Language*	30	2		30				30 +	2					SJO	**ONLINE**
2	Communication and Fundamentals of Negotiation	30	2.5	16	14				30 +	2.5					WLO / IOiZ	
3	Selected Topics in Psychology	30	2.5	16	14				30 +	2.5					WLO / IOiZ	
4	Occupational Health and Safety	4		4					4						BHP	
B.	**Core Subjects**	**68**	**6.5**	**30**	**24**	**14**			**68**	**6.5**						
1	Analytical Mechanics	28	2.5	12	16				28 +	2.5					WIM / IMiIO	
2	Innovation and Entrepreneurship	20	2	12	8				20 +	2					WLO / IOiZ	
Elective Subjects (one of a pair)		**20**	**2**	**6**		**14**			**20**	**2**						
3	Computer Techniques in Structural Analysis	20	2	6		14			20 +	2					WIM / IMiIO	
4	Experimental Techniques in Structural Analysis															
C.	**Field-Specific Subjects**	**313**	**25.5**	**129**	**64**	**120**			**98**	**8**	**215**	**17.5**				
1	Introduction to Digital Measurements	30	2.5	12	12	6			30 +	2.5					WIM / IPiT	
2	Introduction to Elasticity and Plasticity Theory	40	3	30	10				40 x	3					WIM / IMiIO	
3	Modern Engineering Materials	28	2.5	16		12			28 +	2.5					WTC / IIM	
4	Automatics and Robotics	30	2.5	14	6	10					30 +	2.5			WIM / IPiT	
5	Integrated Manufacturing Systems	28	2.5	12	8	8					28 +	2.5			WTC / IIM	
6	Machine Design	56	4.5	16	16	24					56 +	4.5			WIM / IRiKM	
7	Machinery Modelling and Simulations	56	4.5	14	12	30					56 x	4.5			WIM / IRiKM	
8	Universal Design in Modelling and Numerical Analyses	45	3.5	15		30					45 +	3.5			WIM / IMiIO	
D.	**Elective Subjects (one of each pair)**	**345**	**29**	**147**	**88**	**104**		**6**	**110**	**8.5**	**150**	**12.5**	**85**	**8**		
1	Engines of Mechanical Vehicles	30	2.5	16	8	6			30 x	2.5					WIM / IPiT	
2	Hybrid and Electric Propulsion Systems															
3	Hydraulic Systems for Mobile Applications	40	3	24	16				40 +	3					WIM / IRiKM	
4	Theory of Land Locomotion															
5	Mechanisms Modelling in CATIA	40	3	4		36			40 +	3					WIM / IRiKM	
6	Parts Design in CATIA															
7	Computer-Based Fatigue Calculations	30	2.5	10		20					30 +	2.5			WIM / IMiIO	
8	Numerical Modelling of Materials															
9	Devices for Transport and Distribution of Service Fluids	30	2.5	16	10**			4			30 +	2.5			WIM / IPiT	
10	Fundamentals of Tribology															
11	Engineering Systems in Mobile Applications	30	2.5	14	16						30 +	2.5			WIM / IRiKM	
12	Programmable Control of Mechatronics Systems															
13	Experimental Vehicle Testing	20	2	10	4	6					20 +	2			WIM / IPiT	
14	Military Vehicle															
15	FEM and Simulation of Linear Problems of Mechanics	40	3	10	10	20					40 +	3			WIM / IMiIO	
16	Multibody Simulation in Mechanical Engineering															
17	Aspects of Road Transport of Hazardous Materials	20	2	12	8								20 +	2	WIM / IPiT	
18	Transport of Goods															
19	Fundamentals of Mechanical Vibrations	20	2	12	6			2					20 +	2	WIM / IPiT	
20	Transport Logistics															
21	Hybrid and Electric Vehicles Maintenance and Safety	30	2.5	12	10	8							30 +	2.5	WIM / IPiT	
22	Repair Technology of Vehicles															
23	Modern Measurement Systems	15	1.5	7		8							15 +	1.5	WIM / IRiKM	
24	Navigation and Positioning Systems															
E.	**Thesis**	**20**	**22**					**20**					**20**	**22**		
1	Graduation Seminar	20	2					20					20 +	2	WIM	
2	Thesis		20											20	WIM	
	TOTAL NO. OF HOURS / ECTS credits	**840**	**90**	**342**	**234**	**238**		**26**	**370**	**30**	**365**	**30**	**105**	**30**		
	Acceptable deficit of ECTS credits								**16**		**16**					
	Type and number of required evaluations: no. of exams x								**2**		**1**					
	no. of assessments +								**10**		**9**		**5**			
	no. of interim projects															

* to choose from German or Russian

** 10 hours in the form of practical classes (D9) or laboratories (D10)

Plan of studies authorised by the Senate of WAT on **November 30, 2023**

"ONLINE" written in the Comments section means that the class (lectures, practical classes, laboratories, projects, seminars) can be conducted with methods and techniques of distance education.

organisational units

WIM – Faculty of Mechanical Engineering
IMiIO – Institute of Mechanics and Computational Engineering
IPiT – Institute of Vehicles and Transportation
IRiKM – Institute of Robots and Machine Design
WLO – Faculty of Security, Logistics and Management
IOiZ – Institute of Organisation and Management
WTC – Faculty of Advanced Technologies and Chemistry
IIM – Institute of Materials Science and Engineering
SJO – Foreign Languages College
BHP – Occupational Health and Safety Team

Wojskowa Akademia Techniczna

Wydział Inżynierii Mechanicznej

Opinia
Wydziałowej Rady ds. Kształcenia
Wydziału Inżynierii Mechanicznej
Wojskowej Akademii Technicznej
im. Jarosława Dąbrowskiego

nr 2/11/WRK/WIM/2023 z dnia 21 listopada 2023 r.

w sprawie opracowanego projektu programu studiów drugiego stopnia na kierunku studiów „mechanika i budowa maszyn" prowadzonych w języku angielskim

Na podstawie § 92 ust. 1 pkt. 1 Statutu WAT, stanowiącego załącznik do uchwały Senatu WAT nr 16/WAT/2019 z dnia 25 kwietnia 2019 r. *w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego* (t.j. Obwieszczenie Rektora nr 1/WAT/2021 z dnia 21 października 2021 r.) postanawia się, co następuje:

§ 1

Wydziałowa Rada ds. Kształcenia Wydziału Inżynierii Mechanicznej pozytywnie opiniuje opracowany projekt programu studiów drugiego stopnia na kierunku studiów „mechanika i budowa maszyn" o profilu ogólnoakademickim, prowadzonych w języku angielskim, rozpoczynających się od roku akademickiego 2023/2024.

Przewodniczący
Wydziałowej Rady ds. Kształcenia

dr inż. Piotr SZURGOTT

Wojskowa Akademia Techniczna

Samorząd Studencki

Egz. nr 2

UCHWAŁA
Rady Samorządu Wydziału Inżynierii Mechanicznej
Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego

nr 07/RSWIM/2023 z dnia 16 listopada 2023 r.

w sprawie zaopiniowania programu studiów

Na podstawie § 41 Regulaminu Samorządu Studenckiego WAT, stanowiącego załącznik do uchwały Parlamentu SS WAT Nr 14/PAR/2019 z dnia 16 listopada 2019 r. (t.j. obwieszczenie Przewodniczącej SS WAT nr 1/PSS/2023 z 23 stycznia 2023 r.), uchwala się, co następuje:

§ 1

Pozytywnie opiniuje się projekt programu studiów drugiego stopnia na kierunku „Mechanika i budowa maszyn" prowadzonych w języku angielskim.

§ 2

Uchwała wchodzi w życie z dniem podpisania.

Przewodnicząca Rady Samorządu WIM

Matlewska

Monika MATLEWSKA

Wykonano w 2 egz.:
1) a/a
2) Prodziekan ds. Kształcenia WIM
Sporządziła: Monika Matlewska , ☎ tel.782333717, e-mail: monika.matlewska@student.wat.edu.pl