Wojskowa Akademia Techniczna

Uchwała
Senatu Wojskowej Akademii Technicznej
im. Jarosława Dąbrowskiego

nr 86/WAT/2021 z dnia 28 października 2021 r.

w sprawie ustalenia programów studiów
dla kierunku studiów „materials engineering”

Na podstawie art. 28 ust. 1 pkt 11 ustawy z dnia 20 lipca 2018 r. - Prawo o szkolnictwie wyższym i nauce (Dz. U. z 2021 r., poz. 478 z późn. zm.) oraz § 21 ust. 1 pkt 21 i § 81 ust. 10 i 11 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 (tj. obwieszczenia Rektora WAT nr 1/WAT/2021 z dnia 21 października 2021 r.), po zasięgnięciu opinii samorządu studenckiego, na wniosek rektora uchwala się, co następuje:

§ 1

Ustala się program studiów drugiego stopnia o profilu ogólnoakademickim dla kierunku studiów „materials engineering”, prowadzonych w formie stacjonarnej, rozpoczynających się od roku akademickiego 2021/2022, stanowiący załącznik do uchwały.

§ 2

Uchwała wchodzi w życie z dniem podjęcia

Przewodniczący Senatu

(-) płk prof. dr hab. inż. Przemysław WACHULAK

Appendix
to Senate Resolution No. 86/WAT/2021
dated 28 October 2021

WOJSKOWA AKADEMIA TECHNICZNA
im. Jarosława Dąbrowskiego
(Military University of Technology)

PROGRAMME OF STUDY

Level: **Second cycle studies**

Major: **MATERIALS ENGINEERING**

Resolution of the Senate of Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego No. 86/WAT/2021 of 28 October 2021

authorising the adoption of a programme of study for a degree in ***Materials Engineering***

Effective from the academic year 2021-2022

Warsaw

2021

PROGRAMME OF STUDY

Major: MATERIALS ENGINEERING

Level: **Second cycle studies**

Profile: **General academic profile**

Mode: **Full-time**

Degree awarded to graduates: **magister inżynier** *(Master Engineer)*

Polish Qualifications Framework Level: **7**

Classification of the major:

Branch of science: **Engineering and Technical Sciences**
Scientific field: **Materials Engineering** (100% ECTS)

Language of instruction: **English**

No. of semesters: **3**

Total no. of hours: **866**

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

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: **51**
- humanities or social sciences courses[1]: **5**

Length, no. of ECTS credits, rules and form of internship:
No internship required by the programme of study.

[1] *Not applicable to majors that fall into the field of humanities or social sciences respectively.*

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*[4]*_WG - description component code for second-cycle characteristics for level 7 qualifications of the Polish Qualifications Framework.*

[2] *Applicable to majors that finish with the award of the following degrees: inż., mgr inż.*
[3] *For engineering qualifications.*

Outcome Symbol and Number	Description of Learning Outcomes	Description Component Code
KNOWLEDGE	**Graduate:**	
K_W01	Has a deep knowledge and understanding of the nature, role and significance of social sciences and humanities and of their relationship to other sciences.	P7S_WG
K_W02	Has a knowledge of selected concepts and laws of solid-state physics. Has a knowledge of the band theory for solids and the optical phenomena in semiconductors. Knows the fundamentals of superconductivity.	P7S_WG
K_W03	Has broadened his/her knowledge of the physical properties of solids, in particular, in respect of the effects of light on materials. Knows the basic optical properties of crystals, the theoretical foundations of description of nonlinear optical properties and properties of smart materials.	P7S_WG
K_W04	Has a good knowledge of the theories of chemical bonding and the theoretical foundations of molecular spectroscopy. Is acquainted with the fundamentals of computational techniques of theoretical chemistry and the applications of quantum mechanics in materials engineering.	P7S_WG
K_W05	Has a good knowledge of the structure of materials, the mechanisms of phase transitions in materials, the role of diffusion in the formation of structures, maintenance of thermodynamic stability, degradation of the properties of materials. Knows the methods for the quality control of construction and functional materials. Is acquainted with the methods of nondestructive testing.	P7S_WG
K_W06	Knows the spectroscopic methods of surface analysis. Has a knowledge of the methods for analysis of thermal, optical, electrical and magnetic properties. Is acquainted with computer-based techniques for analysis of the structure and properties of materials.	P7S_WG
K_W07	Knows the fundamentals of crystallographic computing, mathematical description of symmetry of crystals and basic diffraction methods for crystal structure analysis. Is acquainted with the types and classification of crystal defects and with the tensor analysis of physical properties of crystals and their relationship to symmetry. Knows the concepts of group theory and the fundamentals of their applications in crystallography, in particular, in materials engineering.	P7S_WG
K_W08	Has a knowledge of the measurement applications of computers. Is acquainted with the structure and application of selected measurement system interfaces. Knows how to use computers in conducting analyses.	P7S_WG
K_W09	Knows how to select construction and functional materials suitable for engineering applications. Knows the fundamentals of design of the structure of engineering materials taking into account the required physical, chemical and operational properties.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W10	Has a knowledge of the advanced production techniques for semi-finished and finished products made of metal, ceramic or composite materials. Is acquainted with software designed for computer-aided manufacturing.	P7S_WG Inż_P7S_WG
K_W11	Knows the fundamentals of construction of materials, the concept of the structure of materials, the phase transition mechanisms in materials, the relationship between parameters of primary technological processes and the structure of materials, and between the structure and properties of materials.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK

K_W12	Knows the basic applications of functional materials: semiconductors, materials with specified properties for laser and optical fibre system construction, smart materials, materials for renewable energy applications, liquid crystal materials, shape-memory materials, photo- and thermochromic materials, magnetostrictive materials, electro-, photo- and radioluminescent materials, etc. Is acquainted with the trends and directions in the development of such materials.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W13	Knows the basic applications of construction materials: unalloyed and alloy construction steels, steel and other tool alloys, special purpose steel and other alloys of iron subject to plastic forming, cast iron, cast steel, alloys of aluminum, copper, magnesium, titanium, nickel, cobalt, zinc and other special purpose alloys used in the construction of machinery and equipment. Is acquainted with potential applications of these materials, the trends and directions in their development.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W14	Knows the fundamentals and methods of research, measurement, analysis and description of the structural parameters of materials, including macroscopic, optical and electron microscopic methods, X-ray structural analysis, macro- and microanalysis of chemical composition, analysis of local crystallographic orientation, quantitative analysis of the ratio of structural elements and phase transitions.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W15	Knows the methods of research, analysis and description of performance of materials, in particular, hardness and microhardness testing, measurement of mechanical properties in response to load per single and multiple axes, fatigue testing, wear testing, corrosion testing, and the methods for detection of defects and damage in materials using destructive and nondestructive testing.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W16	Has a knowledge of the lifecycle of equipment, structures and systems, in particular, such applicable to materials engineering research and operations.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W17	Has a knowledge and understanding of the foundations of crystalline and amorphous material technology based on a sound knowledge of the structure of condensed matter.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W18	Knows the methods for producing coating layers with specific properties and for specific applications, as well as layers of monocrystalline semiconductors. Knows the physical phenomena and laws employed in the making of layers and the growth mechanisms for multiple atomic layers and thin monocrystals. Knows the system configurations used in particular growth techniques and the methods for controlling the growth process and layer parameters.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W19	Knows the basic methods for the production and processing of construction materials. Is acquainted with the main phases of metallurgical engineering of iron alloys and non-ferrous alloys, and with the various applications of non-conventional manufacturing methods.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W20	Knows the principles of design of technological processes and of selection of the parameters of those processes at the stage of production of standard machine parts, in particular, by casting, powder metallurgy, plastic forming, thermal or thermochemical treatment, bonding, material removal process, treatment modifying the outer layer and finishing treatments.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK

K_W21	Knows computer-aided engineering tools for materials technology as well as design and production of machine parts.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W22	Knows the common types of loads and forces that affect standard engineering structures and their effects on the performance and durability of construction materials and the elements made of them.	P7S_WG P7S_WK Inż_P7S_WG Inż_P7S_WK
K_W23	Has a knowledge of the economic and environmental aspects of production and use of materials to the extent necessary to understand the social, economic, legal and other non-technical effects of engineering. Is acquainted with the cost components of production, the environmental hazards associated with production and use of materials and ways to protect the environment. Knows how to minimise waste and can provide examples of zero waste technologies, technologies ensuring energy and material efficiency, environment-friendly technologies.	P7S_WK Inż_P7S_WK
K_W24	Has a knowledge and understanding of basic concepts, rules and regulations of law pertinent to industrial property and copyright protection. Knows the rules governing the use of patent data.	P7S_WK Inż_P7S_WK
K_W25	Knows general rules guiding the formation and development of individual enterprises, in particular in the sectors of economy that rely on the findings of engineering, including materials engineering and related disciplines.	P7S_WK Inż_P7S_WK
SKILLS	**Graduate:**	
K_U01	Demonstrates a knowledge of foreign language consistent with B2+ level according to the Common European Framework of Reference for Languages, which allows for spoken and written communication on general topics and advanced communication using specialist terminology.	P7S_UK
K_U02	Is able to identify and interpret the fundamental social, humanistic and legal phenomena and processes to the extent relevant to the chosen field of study.	P7S_UW
K_U03	Is able to retrieve information from reference literature, databases or other properly chosen sources, including in English or other foreign language recognised as the language of international communication in materials engineering. Is able to integrate the retrieved information, interpret it and analyse it critically, and to draw conclusions and formulate and explain the reasons for opinions.	P7S_UW P7S_UO
K_U04	Is able to communicate using a variety of techniques in the professional and other circles. In particular, is able to use information and communication technologies suitable for the accomplishment of objectives characteristic of engineering.	P7S_UK
K_U05	Is able to write a well-documented topical study in English and in a foreign language in the form of an engineering expert opinion or research paper in the field of materials engineering.	P7S_UK P7S_UO Inż_P7S_UK Inż_P7S_UO
K_U06	Is able to identify directions for future learning and to further his/her education through self-study.	P7S_UO P7S_UU
K_U07	Is able to plan and conduct experiments, including computer measurements and simulations, interpret results and draw conclusions.	P7S_UW P7S_UO Inż_P7S_UW Inż_P7S_UO
K_U08	Is able to use analytical, simulation and experimental methods in formulating and solving engineering problems and simple research problems.	P7S_UW P7S_UO

K_U09	Is able to formulate and solve engineering problems by integrating the knowledge of branches of science and scientific disciplines relevant to materials engineering, and to use the systemic approach taking into account non-technical aspects.	P7S_UW P7S_UU
K_U10	Is able to formulate and test hypotheses associated with simple research problems.	P7S_UW P7S_UU
K_U11	Is able to determine the usefulness and applicability of new advances (techniques and technology) in materials engineering.	P7S_UW P7S_UU Inż_P7S_UW Inż_P7S_UU
K_U12	Is able to work in an industrial environment and knows the safety rules that apply to it.	P7S_UO P7S_UU
K_U13	Is able to critically analyse the operation and evaluate – specifically in relation to materials engineering – existing technical solutions, in particular, equipment, structures, systems, processes and services. Is able to suggest improvements (upgrades) on the existing technical solutions.	P7S_UW P7S_UO Inż_P7S_UW Inż_P7S_UO
K_U14	Is able to identify and formulate specifications of complex engineering problems characteristic of materials engineering, including atypical problems, taking into account their non-technical aspects.	P7S_UW P7S_UU
K_U15	Is able to determine the usefulness of methods and tools in solving engineering problems characteristic of materials engineering, and to identify the limitations of those methods and tools. Is able to solve complex engineering problems characteristic of materials engineering, including atypical problems and problems with a research component, also by using conceptually new approaches.	P7S_UW P7S_UO Inż_P7S_UW Inż_P7S_UO
K_U16	Is able to design – following the required specifications and taking into account non-technical aspects – a complex device, structure, system or process related to materials engineering, and to execute the project by using appropriate methods, techniques and tools, also by adapting any existing or developing new tools.	P7S_UW P7S_UU
K_U17	Is able to perform an economic analysis of undertaken engineering and research activities.	P7S_UW P7S_UO
SOCIAL COMPETENCES	**Graduate:**	
K_K01	Recognises the need for continuous learning and development of competences, knows how to inspire others to learn.	P7S_KK
K_K02	Recognises the non-technical aspects and effects of engineering and research activities. Is able to assess their impact on the environment. Is capable of responsible decision-making in the context of the above aspects.	P7S_KK P7S_KO
K_K03	Is capable of leading a team. Interacts with a group, inspires and organises public interest initiatives.	P7S_KO P7S_KR
K_K04	Is able to identify priorities and define the technical and non-technical conditions at the stage of task planning and execution.	P7S_KK P7S_KO
K_K05	Recognises and resolves dilemmas associated with engineering, research and production.	P7S_KK P7S_KR Inż_P7S_KK Inż_P7S_KR
K_K06	Thinks and acts creatively and possesses an entrepreneurial mindset.	P7S_KO P7S_KR
K_K07	Recognises the social role of graduates of technological education institutes. Understands the need for formulating and communicating to the public information on the advances in science and technology. Acts accordingly.	P7S_KK P7S_KO P7S_KR

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

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
General Education - General Subjects				
1.	COMMUNICATION AND FUNDAMENTALS OF NEGOTIATION Contents of the framework programme: 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**	IMat	K_W01 K_W23 K_U02 K_U04 K_K01 K_K04 K_K05
2.	**SELECTED TOPICS IN PSYCHOLOGY** Contents of the framework programme: The course covers selected topics in general and social psychology. It allows students to broaden and extend their psychological knowledge about oneself and others, useful at work and in everyday life, and to develop practical skills: open-mindedness, willingness to take on challenges, out-of-the-box thinking and teamwork skills.	**2.5**	IMat	K_W01 K_U02 K_U06 K_K01 K_K02 K_K03
3.	**OCCUPATIONAL HEALTH AND SAFETY** Contents of the framework programme: 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.	**-**		K_U12 K_U14 K_K02 K_K04
4.	**PRESENTATION OF SCIENTIFIC AND TECHNICAL SUBJECTS** Contents of the framework programme: Terminology of mathematics, general physics, rudiments of general and inorganic chemistry, material engineering, construction and functional materials, measurement techniques applied in materials engineering, conference presentation, papers, groundwork for computer presentation of scientific problems.	**4.0**	IMat	K_W02 K_W03 K_W04 K_U03 K_U05 K_K05 K_K07
Core Education - Core Subjects				

[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	Field code	Reference to major-specific outcomes
1.	**MATHEMATICS** Contents of the framework programme: This course aims to help students understand basic concepts and theorems of mathematics and master basic arithmetic skills and knowledge in the following areas: groups and subgroups, transformation groups, group representations, fundamentals of the calculus of variations, extrema and extremals of functionals.	**3.0**	IMat	K_W07 K_U03 K_U08
2.	**PHYSICAL FOUNDATIONS OF ANALYTICAL METHODS** Contents of the framework programme: The quantum theory and introduction to the quantum mechanical model, postulates of quantum mechanics, the Schrödinger equation in quantum mechanics used to interpret physical phenomena and the structure of atoms and molecules, approximation methods in theoretical chemistry, basic interpretations of spectroscopic methods with the quantum mechanical model, fundamentals of molecular modelling based on commercial software.	**3.0**	IMat	K_W04 K_W06 K_W09 K_U03 K_U07 K_K04
3.	**COMPUTER-AIDED MEASUREMENTS** Contents of the framework programme: Becoming acquainted with interface systems used in measurements and control of external devices. Becoming acquainted with the fundamentals of programming in LabView. Developing an original programming algorithm for controlling a specified device according to predetermined assumptions. Becoming acquainted with the fundamentals of programming in Keysight Vee, including the logic of the graphical language. Developing and testing an original programme for controlling an external device.	**3.0**	IMat	K_W08 K_U07 K_U08 K_U13 K_K03 K_K04 K_K05
4.	**PHYSICAL PROPERTIES OF SOLIDS** Contents of the framework programme: The course provides students with extensive knowledge of the physical properties of solids and the associated causal effects resulting from exposure to selected external factors.	**3.0**	IMat	K_W02 K_W13 K_W14 K_W16 K_W17 K_U07 K_U09 K_U11 K_K06

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
5.	**STRUCTURE AND PROPERTIES OF MATERIALS** Contents of the framework programme: The structure of engineering materials (revision with concurrent introduction of English terminology). The theory and technology of heat and chemical treatment of technical alloys. The structure and properties of technical ceramics and polymers. The structure and properties of composite materials. The actual structure of construction and multifunctional materials. The impact of various technological processes on changes in macrostructure and macroscopic characteristics of materials. Material aspects of wear and destruction of structural elements. Technological and operational surface layer, structural degradation during operation: conditions relating to load and environment, structural conditions of those phenomena. Thermal stability of the structure and properties of technical alloys.	**4.0**	IMat	K_W05 K_W11 K_W13 K_U03 K_U09 K_U13 K_K01 K_K04
6.	**SELECTION OF ENGINEERING MATERIALS** Contents of the framework programme: Students will become acquainted with the strategy for selecting materials for machinery and devices, auxiliary factors in the selection of materials and production technology and practical applications of the CES software modules. The topics covered by the course include e.g. use of functionality indexes, microscopic and macroscopic form factor of a product and eco-friendly design in consideration of energy expenditure.	**3.0**	IMat	K_W09 K_W13 K_W16 K_U03 K_U11 K_U16 K_K01 K_K04 K_K06
7.	**COMPUTER-AIDED ANALYSIS OF THE STRUCTURE OF MATERIALS** Contents of the framework programme: The course aims to acquaint students with the methods of evaluation of materials based on computer-integrated systems designed for analysis of the image, identification of the chemical and phase composition and the crystal structure of engineering materials.	**2.0**	IMat	K_W08 K_W14 K_U07 K_K01 K_K04
Major Education - Major Subjects				
1.	**MODERN CONSTRUCTION MATERIALS** Contents of the framework programme: The course aims to acquaint students with engineering materials used in the contemporary technology with special focus on the relationship between structure, properties and application. The course also looks into selection of appropriate materials and discusses the methods of production of materials, including the latest technical solutions.	**6.0**	IMat	K_W09 K_W13 K_U11 K_K01

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
2.	**FUNCTIONAL MATERIALS IN MATERIALS ENGINEERING** Contents of the framework programme: Basic properties of semiconductors used in optoelectronic devices: band structures, absorption ratio, carrier mobility, generation and recombination mechanisms, III-V compound semiconductors used in semiconductor lasers, II-VI solid solutions in the detection of IR radiation. Low-dimensional quantum structures (quantum wells, superlattices, quantum dots) in the detection and generation of electromagnetic radiation.	**6.0**	IMat	K_W02 K_W03 K_W12 K_U01 K_U02 K_U03 K_U04 K_K01 K_K01 K_K05
3.	**ENGINEERING PLASTICS FORMING AND PROCESSING TECHNOLOGIES** Contents of the framework programme: Metallurgy and casting methods. Powder metallurgy. Forming processes. Thermal bonding of metals. Methods of modification of the surface layer of construction materials. Subtractive processing with elements of computer-aided processing. Fundamentals of additive manufacturing of components.	**4.0**	IMat	K_W10 K_W11 K_W19 K_W20 K_U03 K_U11 K_K02 K_K07
4.	**ADVANCED APPLICATIONS OF LIQUID CRYSTALLINE MATERIALS** Contents of the framework programme: Introduction to photonic materials. Advanced applications of liquid crystals. Transmission of light through birefringent medium. Physical foundations of optical effects, including in physical fields - the Pockels effect, the Kerr effect, the Faraday effect, thermo-optic effects. Applications of optical isolators and filters. Properties and advanced applications of liquid crystalline materials – dynamic optical filter, optical valve, light polarisation switch. Eye protection solutions based on photonic materials and structures.	**4.0**	IMat	K_W12 K_W15 K_W18 K_W19 K_W20 K_U01 K_U04 K_K01 K_K04
Elective Subjects				
1.	**MATERIALS MANUFACTURED WITH ADDITIVE TECHNIQUES** Contents of the framework programme: The concept and basic assumptions of processes based on additive techniques. Specifications of materials used in additive techniques such as Rapid Prototyping and Rapid Manufacturing. Fundamentals of micrometallurgy of selected metal alloys. The structure and properties of materials manufactured with additive techniques. Post-processing and quality approval of components manufactured with additive forming techniques.	**3.0**	IMat	K_W10 K_W11 K_W14 K_W15 K_W20 K_U03 K_U04 K_U08 K_U15 K_U11 K_K01 K_K04 K_K05

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
2.	**MATERIALS AND TECHNOLOGIES FOR OPTICAL FIBRE PHOTONICS** Contents of the framework programme: Comprehensive discussion of the technological foundations of optical fibre manufacturing from the point of view of its applications, including the fundamentals of light wave propagation within the structure of cylindrical waveguides.	**3.0**	IMat	K_W01 K_W18 K_W20 K_U08 K_U14 K_K03 K_K11
3.	**METALLOGRAPHIC PREPARATION II** Contents of the framework programme: The course aims to acquaint students with the preparation of samples for metallographic analysis (e.g. porous materials, sintered materials, multiphase materials etc.). It discusses the rules for collecting samples and the stages of their preparation (FIB, vacuum sputtering, etc.) depending on the chosen analytical method and potential artefacts and ways to reduce them.	**3.0**	IMat	K_W14 K_W15 K_W20 K_U03 K_U04 K_U05 K_K01 K_K06
4.	**THIN FILM TECHNOLOGIES** Contents of the framework programme: The course provides an overview of thin film technologies, including vacuum deposition. Manufacturing, properties and applications of thin metal films and dielectric thin films, including organic films with an amorphous structure, polycrystalline structure or monocrystalline structure (epitaxy), made of metallic metals, dielectrics, semiconductors or composites, used in advanced products of the electronics industry, in optics, optoelectronics and tribology. Methods and conditions of application of thin film techniques.	**3.0**	IMat	K_W09 K_W11 K_W17 K_W18 K_W20 K_U03 K_U05 K_U09 K_K01 K_K04
5.	**MECHANICAL ALLOYING** Contents of the framework programme: The course acquaints students with the issues related to the use of methods of mechanical fracturing and synthesis of materials, in particular through the use of a ball mill. Course participants will learn about basic equipment used in the mechanical alloying and fracturing, the physical and chemical phenomena that occur during those processes and the properties of materials that determine the effects of fracturing and alloying. Participants who complete the course will be able to choose the right equipment for their needs as well as plan and effectively carry out mechanical fracturing and alloying, including reactive milling in the presence of active gases, with knowledge of the impact of specific technical parameters on the effects of the process.	**2.0**	IMat	K_W08 K_W13 K_W15 K_W18 K_W19 K_W20 K_U05 K_U06 K_K02 K_K03 K_K04
6.	**OPTICAL RESEARCH METHODS** Contents of the framework programme: Methods of geometrical optics, basic concepts of refractometry, light wave interference, fundamentals of microscopy, polarised microscopy, phase-contrast microscopy, polarisation interference microscopy.	**2.0**	IMat	K_W03 K_W04 K_W15 K_U01 K_U02 K_K01 K_K02

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
7.	**HYDROGEN ECONOMY MATERIALS** Contents of the framework programme: Basic assumptions of the hydrogen economy, including its limitations. Overview of the methods of hydrogen storage, including materials for storage of solid-state hydrogen. Materials for hydrogen storage based on adsorption. Low-capacity materials for hydrogen storage in room temperature. Materials for hydrogen storage based on magnesium. Complex hydrides as high-capacity materials for hydrogen storage. Methods of improving materials' hydrogenation capacity. Methods of testing materials for hydrogen storage.	**2.0**	IMat	K_W04 K_W05 K_W09 K_W11 K_W23 K_U03 K_U08 K_U11 K_U17 K_K02 K_K05 K_K07
8.	**MATERIALS FOR RENEWABLE ENERGY APPLICATIONS** Contents of the framework programme: Overview of the environment, conventional and alternative energy sources, fundamentals of thermodynamics and methods of converting energy into work, different methods of energy storage, generating energy from the sun, working principles of solar cells, trends in the development of solar cells, working principles of heat pumps, wind power and its applications, water power, low-temperature thermal energy from seas and oceans, hydrogen as the fuel of the future, hydrogen storage, converting biomass into energy, energy saving, energy-saving technologies.	**2.0**	IMat	K_W03 K_W04 K_W13 K_U03 K_U06 K_K02 K_K03 K_K07
9.	**CERAMICS** Contents of the framework programme: Classification and structural properties of ceramics. Physical and mechanical properties of ceramics. Modern ceramics. Ceramics testing methods.	**3.0**	IMat	K_W09 K_W10 K_W11 K_W14 K_W15 K_U03 K_U04 K_U11 K_K02 K_K07
10.	**LIGHT SOURCES AND THEIR PARAMETERS** Contents of the framework programme: The course provides an overview of the phenomenon of spontaneous and stimulated emission, quantum amplifiers and generators, specific types of lasers and their common applications, properties of laser light, the concept of coherence of light - holography, nonlinear optical phenomena.	**3.0**	IMat	K_W04 K_W13 K_U06 K_U07 K_K03

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
11.	**CORROSION** Contents of the framework programme: Description and classification of corrosion. Overview of methods of quantitative measurement of corrosion, including free potential, corrosion potential, pitting potential and pitting corrosion, density of corrosion current, the phenomena of passivation and repassivation. Methods of protecting materials from corrosion at production stage with coatings, protectors. Methods of qualitative and quantitative assessment of corrosion: voltammetry, gravimetric analysis, electrochemical impedance spectroscopy.	**3.0**	IMat	K_W02 K_W03 K_W04 K_W05 K_W11 K_W15 K_U04 K_U07 K_U08 K_U10 K_U14 K_U15 K_K01 K_K05 K_K07
12.	**PHOTONIC ENGINEERING** Contents of the framework programme: Optics and photonics - contemporary developing technologies. Elements of geometrical optics and wave optics, polarised light, refraction, diffraction and interference, luminescence as the physical foundations of selected photonic elements. Light modulation. Acousto-optics and holography. Electro-optics and optical information processing. Photon optics. Fundamentals of optical cryptography.	**3.0**	IMat	K_W03 K_W09 K_W12 K_W15 K_U07 K_U09 K_U14 K_K01 K_K03
13.	**METAL SCIENCE OF BONDED JOINTS** Contents of the framework programme: The topics covered by the course include e.g.: Fundamentals of the bonding process, metallurgical processes associated with selected bonding methods, the structure and properties of bonded joints (welding, heat-sealed and soldered joints). The structure of a welding joint in non-alloy, low-alloy and high-alloy steels. Moreover, students will be acquainted with the determinants of weldability of basic construction materials, stress and deformation and the problem of cracks in welding joints.	**2.0**	IMat	K_W11 K_W13 K_W15 K_U09 K_U13 K_U14 K_K04 K_K06
14.	**PHOTONIC SENSORS** Contents of the framework programme: Overview of interferometric detection systems. Electronic execution of basic systems used in interferometry, fundamentals of spectral analysis, methods of fibre optic sensing, fibre Bragg gratings, transmission systems, reflective systems.	**2.0**	IMat	K_W01 K_W03 K_W06 K_W12 K_U02 K_U03 K_U15 K_K01 K_K02

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field code	Reference to major-specific outcomes
	Thesis			
1.	**GRADUATION SEMINAR** Contents of the framework programme: Faculty and university guidelines for Magister thesis and final examination. Students present the idea for their final project. Magister thesis writing techniques. Avoiding plagiarism in Magister thesis. Overview of visual communication techniques. Preparation for final examination. Magister thesis progress reporting.	**2.0**	IMat	K_W03 K_W04 K_W08 K_W09 K_W13 K_W18 K_W19 K_W14 K_W15 K_U03 K_U04 K_U08 K_U07 K_U09 K_U01 K_U06 K_U10 K_U12 K_K01 K_K02 K_K04 K_K05 K_K06 K_K07
2.	**THESIS** Contents of the framework programme: Choosing a thesis topic. Conducting a literature review on the chosen topic and proposing a method(s) of solving the problem. Conducting appropriate experiments or reviews, review and design or design using available tools and methods. Presenting results in charts, tables, drawings or in the text form. Using the skills acquired throughout the studies, improving individual work and self-directed learning skills and technical problem solving skills. The scope of work to be performed in the course of the thesis writing process is set out in a thesis schedule which should be used to monitor student's progress with the thesis. The schedule is amended according to the needs of the thesis.	**20.0**	IMat	K_W05 K_W09 K_W13 K_W14 K_W15 K_W16 K_W22 K_W24 K_U03 K_U05 K_U07 K_U09 K_K01 K_K04 K_K05 K_K06

Methods of verification and assessment of learning outcomes[6] achieved by the student throughout the entire education cycle:

The achievement of learning outcomes of the Materials Engineering major is assessed on the basis of grades in exams and non-examinable subjects as well as grades for projects or studies presented at seminars. It is also checked whether student was struck off the register in particular academic years. The ultimate test of the learning outcomes is the thesis writing process. To be able to take the final exam student must meet the requirements set out in the programme of study and submit his/her thesis which must receive a passing grade from thesis supervisor and reviewer. Moreover, a lot of attention is given to results of surveys of graduates. Information on the current degree of achievement of learning outcomes is reviewed by the Faculty Council which, on such basis, improves the programme of study.

The choice of the method of verification of learning outcomes depends on the type of classes and number of hours. Prior to laboratory classes students take a test assessing their knowledge of the task at hand, and after the task is completed students write reports in which they analyse the results and formulate conclusions on the basis of theoretical knowledge. The quality of obtained results is determined by their practical skills of carrying out physical and physicochemical measurements and conducting technological processes (engineering skills). Arithmetic is practised during interactive tutorials. Students are provided with model solutions that they use to solve problems on their own in class and as part of independent study. Students' skills are evaluated on a regular basis in class and through written tests covering particular units of the course. Students' theoretical knowledge is assessed through oral and written assessments and exams. **Student's ability to independently solve problems and present them in a systematic written form is evidenced by their thesis.** The ability to discuss topics related to the studied area and present results of research is checked during subject seminars and graduation seminars.

Detailed information on the methods of verification of learning outcomes achieved by students is provided in subject information sheets.

Plan of Studies - Appendix no. 1

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

Appendix no. 1

Wojskowa Akademia Techniczna

PLAN OF FULL-TIME SECOND CYCLE STUDIES, GENERAL ACADEMIC PROFILE

Appendix no. 1 to the Programme

SCIENTIFIC FIELD: MATERIALS ENGINEERING

MAJOR: MATERIALS ENGINEERING

Specialisations according to elective subjects: D1 - Construction Materials; D2 - Functional Materials

Effective from the academic year 2021-2022

	SUBJECT GROUPS / SUBJECTS		Scientific field	Total no. of hours / ECTS credits		ECTS / science skills development	ECTS part. of academic	Including:					no. of hours/evaluations/ECTS credits per semester: I		II		III		organisational unit administering the course	Comments
				hours	ECTS			lecture	tutorial	laborator	project	seminar	hours	ECTS	hours	ECTS	hours	ECTS		
	A. General Subjects			**124**	**9**	**1**	**5**	**36**	**88**				**34**	**2**	**90**	**7**				
1	Communication and Fundamentals of Negotiation		IMat	30	2,5		1,5	16	14						30 +	2,5			WCY	
2	Selected Topics in Psychology		IMat	30	2,5		1,5	16	14						30 +	2,5			WCY	
3	Occupational Health and Safety			4				4					4 +						BHP	
4	Presentation of Scientific and Technical Subjects		IMat	60	4	1	2		60				30 +	2	30 +	2			WTC/IFT	
	B. Core Subjects			**290**	**21**	**13**	**14**	**118**	**52**	**96**	**8**	**16**	**214**	**16**	**76**	**5**				
1	Mathematics		IMat	46	3	1,0	2	26	20				46 +	3					WCY	
2	Physical Foundations of Analytical Methods		IMat	46	3	2	2	26	12	8			46 +	3					WTC/IFT	
3	Computer-Aided Measurements		IMat	46	3	2	2	14		32			46 +	3					WTC/IFT	
4	Physical Properties of Solids		IMat	30	3	2	2	14		16			30 +	3					WTC/IFT	
5	Structure and Properties of Materials		IMat	46	4	2	3	14		18		14	46 x	4					WTC/IIM	
6	Selection of Engineering Materials		IMat	46	3	2	2	14		22	8	2			46 +	3			WTC/IIM	
7	Computer-Aided Analysis of the Structure of Materials		IMat	30	2	2	1	10	20						30 +	2			WTC/IIM	
	C. Major Subjects			**212**	**20**	**8**	**10**	**72**		**60**		**80**	**120**	**12**	**92**	**8**				
1	Modern Construction Materials		IMat	60	6	2	3	20		20		20	60 x	6					WTC/IIM	
2	Functional Materials in Materials Engineering		IMat	60	6	2	3	20		20		20	60 x	6					WTC/IFT	
3	Engineering Plastics Forming and Processing Technologies		IMat	46	4	2	2	16		10		20			46 x	4			WTC/IIM	
4	Advanced Applications of Liquid Crystalline Materials		IMat	46	4	2	2	16		10		20			46 x	4			WTC/IFT	
	D. Elective Subjects			**210**	**18**	**14**	**11**	**94**		**116**					**120**	**10**	**90**	**8**		
1	Materials Manufactured with Additive Techniques	D1	IMat	30	3	2	2	10		20					30 +	3			WTC/IIM	elective
	Materials and Technologies for Optical Fibre Photonics	D2																	WTC/IFT	
2	Metallographic Preparation II	D1	IMat	30	3	2	2	8		22					30 +	3			WTC/IIM	elective
	Thin Film Technologies	D2																	WTC/IFT	
3	Mechanical Alloying	D1	IMat	30	2	2	1	10		20					30 +	2			WTC/IIM	elective
	Optical Research Methods	D2																	WTC/IFT	
4	Hydrogen Economy Materials	D1	IMat	30	2	2	1	20		10					30 +	2			WTC/IIM	elective
	Materials for Renewable Energy Applications	D2																	WTC/IFT	
5	Ceramics	D1	IMat	30	3	2	2	20		10							30 +	3	WTC/IIM	elective
	Light Sources and Their Parameters	D2																	WTC/IFT	
6	Corrosion	D1	IMat	30	3	2	2	10		20							30 +	3	WTC/IIM	elective
	Photonic Engineering	D2																	WTC/IFT	
7	Metal Science of Bonded Joints	D1	IMat	30	2	2	1	16		14							30 +	2	WTC/IIM	elective
	Photonic Sensors	D2																	WTC/IFT	
	E. Thesis			**30**	**22**	**11**	**11**					**30**					**30**	**22**		
1	Graduation Seminar			30	2	1	1					30					30 +	2		
2	Thesis				20	10	10										240	20		
	TOTAL NO. OF HOURS / ECTS credits			**866**	**90**	**47**	**51**	**320**	**140**	**272**	**8**	**126**	**368**	**30**	**378**	**30**	**120**	**30**		
	Acceptable deficit of ECTS credits												**18**		**15**					
	Type and number of required evaluations:									no. of exams x			3		2					
										no. of assessments +			6		9		4			

Semester II-III - education cycle includes elective subjects

OPINIA

Rady Samorządu Studenckiego Wydziału Nowych Technologii i Chemii WAT

dotycząca projektu **Programu studiów**

Rada Samorządu Studenckiego Wydziału Nowych Technologii i Chemii WAT po zapoznaniu się z przedstawionym projektem **Programu stacjonarnych studiów drugiego stopnia** o profilu ogólnoakademickim na kierunku **materials engineering** prowadzonych w języku angielskim i rozpoczynających się w roku akademickim 2021/2022 nie wnosi uwag oraz propozycji zmian i tym samym wyraża o nim pozytywną opinię.

Przewodniczący Rady Samorządu WTC

st. szer. pchor. inż. Wojciech Lasek

Wojskowa Akademia Techniczna

Uchwała
Rady Dyscypliny Naukowej „Inżynieria Materiałowa"
Wojskowej Akademii Technicznej
im. Jarosława Dąbrowskiego

nr 44/RDN_IMat/2021 z dnia 9 września 2021 r.

w sprawie zaopiniowania projektu programu studiów drugiego stopnia prowadzonych w języku angielskim na kierunku inżynieria materiałowa rozpoczynających się w roku akademickim 2021/2022

Na podstawie § 25 ust. 1 pkt 13 Statutu WAT, stanowiącego załącznik do uchwały Nr 16/WAT/2019 Senatu WAT z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (t.j. obwieszczenie Rektora WAT nr 2/WAT/2019 z dnia 9 października 2019 r.), uchwala się, co następuje:

§1

Rada Dyscypliny Naukowej „Inżynieria Materiałowa" pozytywnie opiniuje projekt programu studiów drugiego stopnia prowadzonych w języku angielskim na kierunku inżynieria materiałowa rozpoczynających się w roku akademickim 2021/2022 na Wydziale Nowych Technologii i Chemii.

§ 2

Uchwała wchodzi w życie z dniem podjęcia.

Przewodniczący

prof. dr hab. inż. Tomasz CZUJKO

Wojskowa Akademia Techniczna

Wydział Nowych Technologii i Chemii

STANOWISKO

Wydziałowej Rady ds. Kształcenia
Wydziału Nowych Technologii i Chemii

nr 10/WRK/WTC/2021 z dnia 09 września 2021 r.

w sprawie wyrażenia opinii o Programie studiów drugiego stopnia na kierunku inżynieria materiałowa rozpoczynających się w roku akademickim 2021/2022 prowadzonych w języku angielskim

Na podstawie § 92 ust. 1 pkt 1 Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego, stanowiącego załącznik do uchwały Nr 16/WAT/2019 Senatu WAT z dnia 25 kwietnia 2019 r. w sprawie uchwalenia Statutu Wojskowej Akademii Technicznej im. Jarosława Dąbrowskiego (t. j. obwieszczenie Rektora WAT nr 2/WAT/2019 z dnia 9 października 2019 r.), postanawia się, co następuje:

§ 1

Pozytywnie zaopiniować przedstawiony w Załączniku nr 3 do protokołu z posiedzenia WRK w dniu 09 września 2021 roku opracowany program studiów drugiego stopnia na kierunku inżynieria materiałowa rozpoczynających się w roku akademickim 2021/2022 prowadzonych w języku angielskim.

§ 2

Przekazać Dziekanowi WTC zaopiniowany program.

PRZEWODNICZĄCY
Wydziałowej Rady ds. Kształcenia
Wydziału Nowych Technologii i Chemii WAT

dr inż. Zbigniew ZARAŃSKI, prof. WAT

Sporządziła Alicja Sikorska – sekretarz WRK