Appendix
to Senate Resolution No. 97/WAT/2021
dated December 21, 2021

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

PROGRAMME OF STUDY

Level: **Second cycle studies**

Major: **Optoelectronics**

Resolution of the Senate of Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego No. 97/WAT/2021 of December 21, 2021

authorising the adoption of a programme of study for a degree in ***Optoelectronics***

Effective from the academic year 2022-2023

Warsaw

2021

PROGRAMME OF STUDY

Major: OPTOELECTRONICS

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: **Automatics, Electronics and Electrical Engineering**

Language of instruction: **English**

No. of semesters: **3**

Total No. of hours: **940**

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: **47.5**
- humanities or social sciences courses:[1] **5**

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

Length, No. of ECTS credits, rules and form of internship:

Every student of the Optoelectronics major is obliged to apprenticeship.

The volume of required apprenticeship weeks: **not less than 2**
No. of ECTS credits required: **2**

The apprenticeship is integral part of the process of learning at the Optoelectronics major. The plan of studies provide information about the length of apprenticeship and related ECTS credits. The apprenticeship during the studies of second level has a specialized nature. Trainings are organized in the period from July to September after the completion of the 1st semester. The rules of apprenticeship have been regulated in the decision of the Director of the Institute of Optoelectronics and are consistent with the „Regulation of higher education at the Military University of Technology".

The description of expected learning outcomes includes:
- the universal characteristics of first level specified in the appendix to the Law of 22 December, 2015 on the Integrated Qualifications System.
- the characteristics of second level specified in the appendix to the ordinance of the Minister of Science and Higher Education of 14 November 2018, on the characteristics of second level relating to effects of learning to get skills at levels 6-8 of the Polish Qualifications Frame, including those permitting to get engineering skills[2].

and has been defined in three categories:

- the category of **knowledge (W)**, specifying:
  - the scope and the depth (**G**) – the completeness of cognitive perspectives and dependences.
  - the context (**K**) – the determinants and the consequences.

- the category of **skills (U)**, specifying:
  - as to the use of knowledge (**W**) - the solved problems and the performed tasks,
  - as to the communication (**K**) – the reception and the creation of statements, the popularisation of knowledge in the scientific community and the use of foreign language,
  - as to the organisation of work (**O**) – the planning and teamwork,
  - as to the learning (**U**) – the planning of personal development and development of other persons.

- the category of **social competences (K)** - specifying:
  - as to evaluations (**K**) – the critical approach,
  - as to responsibility (**O**) – the execution of social duties and acting in favour of public interest,
  - as to the professional role - (**R**) – the autonomy and the ethos development.

Explanation of symbols:
- in the column ***symbol and number of the outcome***:
  - K – directional learning outcomes;

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

- W, U, K (after the underscore) – the category – respectively of: knowledge [***w***] , skills [***u***] , social competences [***k***];
- 01, 02, 03, …. - number of the learning outcome.

- in the column ***code of the description element*** - Inż[3]_P7S_WG – the code of description element of second level characteristics for qualification at 7th level of the Polish Qualifications Frame.

Outcome symbol and number	**Description of Learning Outcomes**	**Description Component Code**
	KNOWLEDGE Graduate:	
K_W01	is aware of and understands to a greater extent the nature, the position and the significance of social sciences and humanities and their relationship with other sciences	P7S_WG
K_W02	has an extended and enhanced knowledge in the field of selected parts of mathematics relating to elements of discrete and applied mathematics, including mathematical methods required for creating models and analysing of optoelectronic and electronic systems	P7S_WG
K_W03	can create models and analyze the functioning of elements and analogue and digital optoelectronic circuits	P7S_WG Inż_P7S_WG
K_W04	can create models and analyze the functioning of complex optical, optoelectronic and electronic systems, including systems with programmable circuits	P7S_WG Inż_P7S_WG
K_W05	can create and analyse algorithms applicable to the processing of optical signals, digital signals, including special algorithms applicable to the processing of images	P7S_WG Inż_P7S_WG
K_W06	has extended and improved his/her knowledge in the field of physics, including the elements of quantum physics and solid-state physics, the elements of laser physics, including the knowledge required for understanding the physical phenomena having a great impact on the properties of new materials and the functioning of electronic and optoelectronic elements and is familiar with the methods and forms of description of optical material media and the influence of electromagnetic radiation on material media	P7S_WG Inż_P7S_WG
K_W07	has an enhanced and theoretically supported knowledge in the field of photonics, including knowledge permitting the understanding of functioning of components and systems of optical telecommunication as well as optical recording and information processing and knowledge about phenomena occurring in laser centres and about the properties of active media used in laser centres	P7S_WG Inż_P7S_WG
K_W08	has a structured knowledge as to the use of elements, integrated circuits and electronic and photonic microsystems, has basic knowledge in the field of nanotechnology	P7S_WG Inż_P7S_WG
K_W09	has knowledge as to the use of computers in measurements. Is familiar with the organization and application of selected interfaces of measurement systems, knows how to proceed with research including the use of computers.	P7S_WG Inż_P7S_WG
K_W10	has knowledge in the range of designing of analogue, digital and mixed electronic circuits and electronic systems.	P7S_WG Inż_P7S_WG

[3] *For engineering qualifications.*

	Is familiar with languages of equipment description and computer tools serving the designing and simulation of circuits and systems	
K_W11	has basic knowledge of algorithms used in multimedia applications	Inż_P7S_WG
K_W12	is familiar with and understands the selected methods of artificial intelligence used in the designing of optoelectronic circuits and systems	Inż_P7S_WG
K_W13	has knowledge about the development trends and most important new achievements in the field of optoelectronics and, to a lesser extent, in the field of electronics, informatics and telecommunication	P7S_WG
K_W14	has knowledge about the lifetime of equipment, objects and systems including, in particular those relating to research and activities in the field of optoelectronics	P7S_WG
K_W15	has an extended knowledge in the field of physics and astrophysics, is familiar with and understands physical phenomena and processes occurring in the natural environment, especially in the field of mechanics, electromagnetism, special theory of relativity, elements of quantum mechanics, basic solid-state physics, elements of nuclear physics and plasma physics	P7S_WG
K_W16	has an extended and structured knowledge in the field of photonics, including an extended knowledge of designing and functioning of optoelectronic sensors and equipment .	P7S_WG
K_W17	has an extended and theoretically supported knowledge about the range of electromagnetic fields and waves and wave propagation as well as knowledge required for understanding of generation, modulation and detection and demodulation of optical signals	P7S_WG
K_W18	is familiar with the present state and development trends of satellite and space technics.	P7S_WG
K_W19	has an extended knowledge about the lifetime of satellite and space equipment and systems.	P7S_WG
K_W20	has an enhanced and theoretically extended knowledge of the sending and reception of signals in satellite systems	P7S_WG
K_W21	has an enhanced knowledge of satellite navigation, data reference and modeling systems	P7S_WG
K_W22	has an extended knowledge in the field of analysis and modelling of geophysical phenomena	P7S_WG
K_W23	is familiar with the economic, legal and ethical conditions of exercising professional activity, including the rules of protection of industrial property and copyright	P7S_WK
K_W24	has an extended knowledge of optics and optoelectronic materials science and can use it to analyze and to design optical systems in optoelectronic equipment	P7S_WG
K_W25	has an extended knowledge in the field of sources of electromagnetic radiation, including in particular, solid-state lasers, semiconductor lasers and their use in telecommunication, technology, medicine and scientific research	P7S_WG
K_W26	has an extended knowledge of detection and analysis of optical signals and can use it in such domains of optoelectronics like fibre optics technology, optoelectronic sensors, thermal imaging and infrared technology	P7S_WG
K_W27	has an extended knowledge of mathematical modelling of mechatronic satellite sub-systems and use of obtained results to design and to integrate the mechanical elements.	P7S_WG Inż_P7S_WG
K_W28	has basic knowledge required to understand the non-technical conditions of engineering activity, is familiar with	P7S_WK Inż_P7S_WK

	basic regulations governing the security and hygiene of work.	
	SKILLS Graduate:	
K_U01	may use a foreign language at the level of B2+ of the Common European Framework of Reference for Languages at the level permitting him/her orally and in writing in a general manner and at the higher level as to the specialized terminology	P7S_UK
K_U02	may generate information from the literature, databases and other adequately selected sources, also in English or other foreign language recognized as a language of international communication in the field of optoelectronics, may integrate the obtained information, proceed with their interpretation and critical evaluation as well as draw conclusions and formulate and exhaustively justify opinions.	P7S_UW Inż_P7S_UW
K_U03	may communicate with use of different technics in the professional environment and other environments, and especially may make use of information and communication techniques relevant for executing tasks typical for the engineering activity.	P7S_UK P7S_UW
K_U04	may prepare, in Polish language and foreign language a well-documented report relating to the problem, being an engineering expertise or research work in the field of optoelectronics	P7S_UW
K_U05	may determine the directions of further self-education and realize the process of self-education	P7S_UU
K_U06	may plan and proceed with experiments, including measurements and computer simulations and interpret the obtained results and draw conclusions.	P7S_UW Inż_P7S_UW
K_U07	may use analytical, simulation and experimental methods to formulate and solving of engineering tasks and simple research problems	P7S_UW Inż_P7S_UW
K_U08	may – while formulating and solving engineering tasks – integrate the knowledge of science branches and disciplines related to optoelectronics and apply a systematic approach with consideration of also non-technical aspects	P7S_UW Inż_P7S_UW
K_U09	may formulate and test the hypotheses connected with simple research problems	P7S_UW Inż_P7S_UW
K_U10	may evaluate the utility and the possibility of use of new achievements (techniques and technology) in the field of optoelectronics	P7S_UW Inż_P7S_UW
K_U11	may perform a critical analysis of and evaluate – especially in connection with optoelectronics – the existing technical solutions, including, in particular, equipment, objects, systems, processes and services. He/She may propose improvements of existing technical solutions.	P7S_UW Inż_P7S_UW
K_U12	may proceed with the identification and formulation of the specification of complex engineering, characteristic for optoelectronics, including their non technical aspects	P7S_UW Inż_P7S_UW
K_U13	may evaluate the utility of methods and tools serving the solving of engineering tool characteristics, including limitations of those methods and tools; may – while applying such new methods in new conceptual ways – solve complex engineering tasks, characteristic in optoelectronics, including non typical tasks and tasks comprising a research component	P7S_UW Inż_P7S_UW
K_U14	may – according to the intended specification, comprising non technical aspects – design the submitted equipment, object, system or process, connected with the field of	P7S_UW Inż_P7S_UW

	optoelectronics, and execute that project – with use of relevant methods, techniques and tools, adapting for this purpose the existing or new tools.	
K_U15	may proceed with economic analysis of engineering and research activities	P7S_UW Inż_P7S_UW
K_U16	may make use of analytical, simulation and experimental methods to formulate and solve tasks connected with satellite navigation	P7S_UW Inż_P7S_UW
K_U17	may use optoelectronic materials and selected material technologies in the process of designing and construction of components, equipment and systems used in space and satellite engineering	P7S_UW Inż_P7S_UW
K_U18	may manage the work of the team, collaborate with other persons in the framework of team work and play a leading role in teams	P7S_UO
	SOCIAL COMPETENCES Graduate:	
K_K01	recognizes the need of continuous building of knowledge and competences, knows how to inspire the process of education of other persons, is ready to consult experts in case of difficulties in independent solving of problems	P7S_KK
K_K02	understands the need and knows the possibilities of continuous self-education (studies of third level, postgraduate studies, courses) – increase of professional competences, both personal and social ones.	P7S_KK
K_K03	is aware of the importance of professional conduct, respect of rules of professional ethics and respect for diversity of opinions and cultures	P7S_KO P7S_KR
K_K04	Recognizes the non-technical aspects and consequences of engineering and scientific activity. May critically evaluate their impact on the environment, may decide in a responsible manner taking into consideration the above aspects	P7S_KO P7S_KR
K_K05	Is ready to manage the work of the team, cooperates within the group, inspires and realizes works in favour of public interest.	P7S_KO
K_K06	knows how to formulate priorities and define the technical and non-technical conditions during the planning and execution of tasks	P7S_KK
K_K07	identifies and solves dilemmas connected with engineering, scientific and production activity	P7S_KK
K_K08	is aware of the social role of the graduate of technical university and, in particular, of the need to formulate and to transmit to the community – a/o through mass-media – of information and opinions about the scientific discoveries; makes efforts to transmit such information in a commonly understood way	P7S_KO P7S_KR P7S_KK

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 BASICS OF NEGOTIATIONS*** *Sources of conflicts and their solving. Process, types and functions of communication. The essence and types of negotiations. Strategies, styles and tactics in negotiations. The qualities of the negotiator. Errors in negotiations. Communication in negotiations. Negotiations in practice.*	2.5	NKSM	K_W01 K_U18 K_K01
2.	***SELECTED PSYCHOLOGY ISSUES*** *The programme includes selected issues from the field of general psychology and social psychology. It permits the students to extend and to enhance psychological knowledge about themselves and other persons, useful in their work and life and the development of practical skills: openness to opinions of other persons, readiness for challenges, looking beyond the patterns and ability to work in a team.*	2.5	P	K_W01 K_W23 K_U18 K_K01
3.	***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. Accident insurance. Procedures to be followed in case of accidents and in hazardous situations. Premedical first aid training.*			K_W28 K_U18 K_K05
	Core Education - Core Subjects			
1.	***MATHEMATICAL ANALYSIS*** *The branch serves the students to learn and to understand the basic notions and theorems from selected mathematics sections and to master elementary counting skills with knowledge covering: functions of a complex variable, operational calculus based on the Laplace transform, partial differential equations.*	4.0	AEE	K_W02 K_U02 K_U07 K_K01
2.	***CALCULUS OF PROBABILITIES AND MATHEMATICAL STATISTICS*** *The branch serves the students to learn and to understand the basic notions and theorems of mathematics and especially of the calculus of probabilities and mathematical statistics and to master elementary counting skills with knowledge covering: random variables, parameters of random variables and basic probability distributions, basic statistics and their probability distributions, point and interval estimation,,*	3.5	AEE	K_W02 K_U02 K_U07 K_K01

[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
	verification of parametric hypotheses, correlation and regression analysis. .			
3.	***NUMERICAL METHODS*** *The course is an introduction to numerical methods and includes topics such as numerical accuracy and stability problems, solving systems of equations, interpolation and approximations, calculations of integrals and solving differential equations.*	2.0	AEE	K_W02 K_U02 K_U07 K_U13 K_K02
	Major Education - Major Subjects			
1.	***OPTICS*** *Paraxial geometric optics: ABCD method, geometric imaging in the ABCD system, basic concepts of technical optics, imaging in afocal systems. Review of selected materials and optical elements: material dispersion, Abbe number, GVD group velocity dispersion, review of selected optical materials, review of selected optical elements, measurements of parameters of optical elements. Fundamentals of geometric optics: eiconal equation and ray equation, wave fronts, geometric caustics of rays, GRIN type media, thermal and atmospheric lensing. Polarization of light: Jones formalism, elements changing the polarization state of light, Malus's law, partially polarized radiation, degree of polarization, Stokes vector, Poincare sphere, measurements of the polarization degree. Fundamentals and laws of radiometry: basic quantities of radiometry and photometry, luminosity factors, luminance, etendue conservation, Lambert source imaging Lambert source, HG invariant, m-Lambert source, LED sources, imaging in radiometric approach. Fundamentals of wave optics: paraxial wave equation, ABCD Fresnel transform, Fourier optics, propagation in free space, Fresnel number, diffraction point image, Rayleigh and Sparrow two-point resolution criteria. Angular spectrum of plane waves: solution of the wave equation, Point Spread Function, Optical Transfer Function, imaging of incoherent radiation, imaging of bar tests, images of selected object fields (half-space, line, cross, circle, etc.). Geometric and wave aberrations and imaging quality criteria: ray aberrations, spot diagrams, wave aberrations, Optical Path Difference, Rayleigh max OPD criterion, Marechal rms OPD criterion, criteria based on PSF, Line Spread Function and Modulation Transfer Function, Strehl number, Power in Bucket, Knife Edge Distribution. Elements of the coherence theory: temporal coherence, coherence time & length measurement in the Michelson interferometer, Fourier spectroscopy, spatial coherence, coherence radius, limit coherence functions, theorem. Van-Cittert-Zernike, Gauss-Schell model, stellar interferometry. Basics of optometry: optical characteristics of the eye, visual acuity, hyper-resolution, optical illusions.*	4.0	AEE	K_W17 K_W24 K_W26 K_U10 K_U11 K_U12 K_U13
2.	***FUNDAMENTALS OF QUANTUM ELECTRONICS*** *Fundamentals of quantum mechanics - Heisenberg's uncertainty principle, Hilbert space, Hermite operators,*	3.5	AEE	K_W02 K_W06 K_W07

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	operator equations, measurements in quantum mechanics, postulates of quantum mechanics, Schrodinger's equation, wave function, examples (potential cavity, potential barrier, band structure of semiconductors). Quantum harmonic oscillator. Quantization of electromagnetic field (single-mode field, quantum description of beam splitter). Single-photon experiments. Blackbody radiation. Interaction of radiation with the medium (stimulated and spontaneous transition probabilities, spectral line form). Oscillatory and rotational spectra, quantum numbers for atoms and ions. Laser medium, three and four level systems, material equations. Laser properties of active ions in crystals (rare earth and transition group metal ions). Laser, saturation gain effect, condition for stationary laser generation. Polarizability, dispersion of optical media. Optical properties of anisotropic media, electro-, magneto- and acousto-optic effects. Fundamentals of nonlinear optics: harmonic light generation, three wave mixing. Parametric generation. Stimulated Raman and Brillouin scattering, Kerr effect. Fundamentals of quantum computing (qubits, quantum register, quantum gates, entangled states, quantum information transfer, quantum teleportation).			K_W17 K_W25 K_U05 K_U09 K_U10 K_K01
3.	***E-M RADIATION SOURCES*** *Electromagnetic wave - properties, spectrum of radiation. Coherent and incoherent radiation. Differences in parameters of thermal and laser radiation. Fundamentals of laser construction and radiation generation methods. Parameters of laser beams and methods of shaping the spectral, temporal and spatial parameters of laser beams. Selected gas and solid lasers - structure, parameters. Fiber lasers - structure, parameters. Basic semiconductor materials, emission properties. Optical phenomena in semiconductors. Structure of energy levels and density of states in bands. Outline of the theory of quantum wells and their application in semiconductor lasers. Low-dimensional structures in the construction of sources. Construction and properties of the LED, materials used, construction and technology and applications. The use of LEDs, SLED, OLED. Design conditions of semiconductor radiation emitters. Semiconductor lasers - construction of edge emitters and VCSEL. Construction of selected radiation sources. Spectral and temperature characteristics.*	3.5	AEE	K_W25 K_W03 K_W06 K_W07 K_W13 K_K01 K_K08
4.	***OPTOELECTRONIC MATERIALS SCIENCE & TECHNOLOGY*** *Fundamentals of optical and optoelectronic materials science, mechanisms of interaction of electromagnetic radiation with matter, physical basics of spectroscopic methods, physical basics of selected optoelectronic technologies, principles of using optical and electronic structures, materials and components for the construction of selected optoelectronic devices.*	3.5	AEE	K_W06 K_W07 K_W24 K_W28 K_U06 K_K05

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
5.	***BASICS OF DESIGNING OPTICAL SYSTEMS*** *Basic lecture on modern methods of designing optical elements and systems, including:* *- review of optical elements (lens, mirror, aspherical elements, diffractive elements, optical filters),* *- review of optical systems (imaging lenses, telescopes, microscopes, glasses, spectrometers),* *- introduction to the theory of aberration and imaging (types of aberration, imaging quality criteria, diffraction limit),* *- introduction to optimization methods of optical systems (local and global optimization, the concept of error function, methods from before the computer support era, modern methods),* *- introduction to specialized software decicated for the design and optimization of optical solutions (how to implement an optical system into the software, how to define the fundamental parameters: wavelength, aperture, field angles, how to evaluate the introduced optical system performance, how to improve the system through optimization, how to create optical documentation).*	3	AEE	K_W24 K_U02 K_U05 K_U07 K_U10 K_K01 K_K02
6.	***DETECTORS OF OPTICAL RADIATION*** *Radiometry and photometry. Radiometric and photometric quantities and units. Detector parameters. Detector performance limited by photon noise. Measurements of detector parameters. Noise sources. Fundamentals of optical detection systems. Classification of detectors. Physical basics of thermal detectors operation. Physical principles of photon detectors. Thermopiles. Bolometers. Pyroelectric detectors. Photoemissive detectors. Conventional photocathodes. Photomultipliers. Microchannel plates. Image intensifier systems. Schottky barrier photoemissive detectors. Photoconductive detectors. p-n junction photodiodes. p-i-n photodiodes. Avalanche photodiodes. Schottky-barrier photodiodes. Metal-semiconductor-metal photodiodes. Barrier photodetectors. X-ray and γ-ray detectors. Ultraviolet detectors. Visible detectors. Infrared photodetectors. Extrinsic photoconductors. Quantum well, superlattice and quantum dot photodetectors. Terahertz detectors. Direct and advanced detection systems.*	4	AEE	K_W03 K_W04 K_W08 K_W26 K_U02 K_U06 K_K01
7.	***THREMOVISION AND INFRARED TECHNOLOGY*** *Temperature and heat exchange. Blackbody radiation and non-ideal body radiation. Methods of temperature measurements. Basics of infrared technology. Thermal camera construction and operating principals. Operational parameters of infrared cameras. Algorithms for thermal cameras. Infrared multi and hyperspectral devices. Thermal telemetric measurements. Non-destructive testing in the infrared.*	3.5	AEE	K_W02 K_W26 K_U03 K_U17 K_K01 K_K02
8.	***FIBER OPTIC TECHNOLOGY*** *The aim of the course is to familiarize students with the optical fiber technique and the basics of the technology of producing cylindrical and planar fibers. Applications*	3.5	AEE	K_W26 K_U02 K_U10 K_K01

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	in telecommunications and sensing applications will be presented. The principles of light propagation in optical fibers and the basic phenomena accompanying propagation (attenuation, dispersion) will be discussed. Then, the structure of the basic types of optical fibers and the basic elements used in optical fiber technology (couplers and splitters, modulators, polarizers, multiplexers and demultiplexers, Bragg grids, amplifiers, selected non-linear elements, discriminators, DWDM element, soliton track elements) will be discussed. Attention will be focused on fiber optic links and selected sensors (intensity, phase (fiber interferometers) and polarimetric sensors). Contemporary fiber optic systems and their selected applications will be presented. Selected conditions for the analysis and design of fiber optic links will be presented.			K_K02
	Elective Subjects			
1.	***PROGRAMMABLE LOGIC DEVICES*** *The course encompasses construction, properties and applications of programmable logic devices. Different internal architectures and parameters of selected FPGA and CPLD programmable circuits are presented. The lecture of hardware description languages such as VHDL and Verilog includes numerous examples of projects of functional digital blocks. Programmable logic device design aiding software Intel Quartus is introduced. The students will gain practical skills during 6 laboratory exercises. Two classes are devoted to the design of drivers for imaging CMOS sensor and LCD.*	3.0	AEE	K_W04 K_W10 K_U02 K_U05 K_U07 K_K01
2.	***OPTOELECTRONIC MEASUREMENT*** *The use of optical radiation to measure various physical quantities and selected parameters characterizing material objects. Discussion of methods (technical solutions) for measuring the position, distance and displacement. Speed and acceleration measurement. Interferometric measurements used to measure surface roughness and flatness. Theoretical knowledge related to the physical phenomena used. Selected hardware solutions with technical requirements for the used sources and detectors of optical radiation.*	3	AEE	K_W09 K_W13 K_W16 K_W17 K_U01 K_U06 K_K01
3.	***LASER TECHNOLOGY*** *The aim of the course is to teach students the principles of lasers in various modes of operation, to acquire the ability to analyze and calculate the parameters of simple laser generators and amplifiers, to familiarize with the structure, operation and applications of the most popular solid state and gas lasers. The scope of the course includes the following topics: basics of laser operation, generation conditions, description of pumping in the stationary and dynamic case, pumping techniques, description of laser pulse amplification, laser amplifiers, description of generation in the averaged equation approximation, description and analysis of stationary generation, optimization of*	4.0	AEE	K_W06 K_W07 K_W25 K_U02 K_U05 K_U06 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
	output power, description of pulse generation by Q-switching, active and passive Q-switching, resonator Q-switches, a sketch of the theory of optical resonators, shaping of laser spectral characteristics, single frequency generation, frequency stabilization, tunable lasers, mode-locking, ps and fs pulse generation. A review of the most important lasers will be made in the seminar classes.			
4.	***MULTI AND HYPERSPECTRAL IMAGING SYSTEMS*** *The scope of the course comprises an introduction to construction and operating principles of observational and radiometric multispectral and hyperspectral systems working in the infrared. Theoretical background including laws of radiation for ideal and non-ideal radiators is presented. Further, topics of the course include: analysis of the detection train of multi and hyperspectral imaging system, analysis and processing of multi and hyperspectral measurement data, analysis of measurement conditions and principles of conducting the measurement.*	3	AEE	K_W02 K_W05 K_U02 K_U07 K_U08 K_U13 K_K02
5.	***TERAHERTZ SYSTEMS*** *The aim of the course is to teach students the terahertz (THz) technique and its selected applications. This course will focus on THz sources (semiconductor, photonic) and THz detectors. Particular attention will be paid to photoconductive switches and time-domain spectroscopy. The issues of passive and active imaging of people will be discussed.*	3	AEE	K_W13 K_U02 K_U10 K_K01 K_K02
6.	***SPECTROSCOPY AND OPTICAL IMAGING IN MATERIAL RESEARCH*** *The essence, scope, division of spectroscopy and its application in material research, including optical and optoelectronic research. Review of spectroscopic measurement methods and techniques in the field of UV-VIS-IR. Theoretical foundations of molecular and atomic spectroscopy. Quantitative characteristics of the phenomena of absorption, emission and scattering.*	3	AEE	W06 W09 W15 W24 U06 U07 U10 K01 K02 K03
7.	***PHOTOVOLTAICS SYSTEMS AND DEVICES*** *The module presents the fundamentals of photovoltaic technology and solar energy systems. The main aspects are solar radiation, solar illumination of the ground surface, photovoltaic effect in the p-n junction, parameters and characteristics of photovoltaic cells, installation components, and configuration of photovoltaic systems for either mobile or stationary power sources.*	3	AEE	K_W03 K_W14 K_U02 K_U05 K_U06 K_U15 K_K01 K_K04
8.	***LASER COMMUNICATION SYSTEMS*** *The module presents the fundamentals of wireless optical communication systems (OWC). Analysis of the OWC device's construction and its limitations is performed. Factors influencing both range and data rate have been defined considering conditions of radiation propagation for different environments and various physical phenomena. Significant parameters of*	3	AEE	K_W02 K_W03 K_W06 K_W07 K_W10 K_W13 K_W17 K_U01

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	OWC construction elements (lasers, detectors, optical systems, modulation, and coding techniques) are determined considering the properties of communication systems. The current state of both underwater and terrestrial communication technologies is presented.			K_U02 K_U04 K_U05 K_U06 K_U07 K_U10 K_U13 K_K01 K_K05 K_K06 K_K07
9.	***SECURITY SYSTEMS OPERATION AND USE*** *The class deals with the methodology of preparing for an investment process in the context of security systems for critical infrastructure. It provides information about the bidding procedure, the role of the security systems expert in that procedure, as well as about the criteria used for bid selection and final choice of contractor. Special attention is paid to the problem of including servicing, repairs and system performance checks in cost estimations. It also includes an overview of methods used to determine the extent of a security system's wear and tear.*	2.0	AEE	K_W14 K_U03 K_U08 K_U11 K_K01 K_K06
10.	***OPTOELECTRONICS MONITORING OF INFRASTRUCTURE*** *The course aims to introduce students to optoelectronic systems for the protection of critical infrastructure facilities. Systems intended for the protection of intelligent buildings, banks, museums, monitoring of cities, stadiums, stations and large areas will be characterized. Particular attention will be paid to the organization of city security with a hazard map, cooperation with the police and local government, as well as the organization of monitoring of stadiums with observation of parking lots, entrance gates and stands. The practical knowledge of the student will be enriched by a visit to the Monitoring Center of the Capital City of Warsaw and the National Stadium in order to learn how the security of these facilities is organized and supervised on the streets and stands of the stadium.*	2.0	AEE	K_W04 K_W10 K_W13 K_U02 K_U06 K_K05
11.	***OPTOELECTRONICS IN SECURITY SYSTEMS*** *The course introduces passive and active remote/stand off sensing devices in security systems. After presenting and arranging information related to the propagation of optical radiation in the atmosphere, the devices, their principles of operation, block diagram and characteristic features will be discussed.*	2.0	AEE	K_W16 K_W26 K_U05 K_U09 K_U10 K_K01
12.	***PROCESSING AND ANALYSIS OF IMAGES*** *The aim of the course is to familiarize students with the structure of digital images, image metadata and key issues in the field of their processing and analysis. Various groups of static image processing methods and the basics of working with video sequences will be discussed. Issues in the field of photogrammetry, image quality improvement and analysis will be presented. As part of the exercises and laboratory classes, students will be able to train and practically*	4.0	AEE	K_W02 K_W05 K_W10 K_W13 K_U02 K_U03 K_U04 K_U05 K_U07 K_U13

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	verify their skills by working on both computer-synthesized images and real photo and video materials from various types of vision systems.			K_K01 K_K04 K_K05
13.	***VIRTUAL REALITY TECHNOLOGIES*** *The aim of the course is to familiarize students with the classification of virtual systems, the basics of virtual (VR) and augmented reality (AR) operation and the key components of these technologies, with particular emphasis on optoelectronic solutions. Presentation and interactive systems as well as tracking methods used in virtual technologies will be discussed. The topic of the role of human senses in the perception of the immersive environment and the possibility of the effects of simulator disease as a result of malfunction of selected components of virtual technologies will also be discussed. As part of the laboratory classes, students will be able to practically test the operation of several types of VR / AR applications using various optoelectronic systems.*	2.0	AEE	K_W04 K_W07 K_W09 K_W10 K_W11 K_W13 K_W14 K_U02 K_U03 K_U04 K_U05 K_U06 K_U08 K_U10 K_U12 K_U13 K_K01 K_K04 K_K05 K_K06
14.	***NON-LINEAR OPTICAL CONVERSION OF LASER RADIATION*** *The aim of the course is to familiarize students with the possibilities of generating laser radiation in a wide spectral range. Students will learn about the properties of crystals used for the generation and conversion of optical radiation to other wavelengths and with the systems used for the generation, amplification of laser pulses and optical frequency conversion of laser radiation.*	3.0	AEE	K_W02 K_W06 K_W07 K_W13 K_W17 K_W24 K_U02 K_U13 K_K01
15.	***APPLICATION OF HIGH-POWER PULSED LASERS*** *The subject concerns the use of lasers producing high-power laser pulses in various areas of modern science and technology. During the lectures, the following topics will be discussed: laser systems producing intense pulses of radiation with a duration in the range of 10-9 – 10-15 s; the interaction of high-power laser pulses with matter; generation of laser plasma; laser fusion; laser-driven acceleration of charged particles; generation of X-rays and extreme ultraviolet (EUV) with lasers; application of laser-plasma X-ray and EUV sources; laser research infrastructures ELI, Laserlab-Europe, EuPRAXIA, XFEL, PolFEL. During laboratory classes, students will become familiar with the methods of laser plasma generation and investigations of laser-plasma X-ray and EUV sources.*	2.0	AEE	K_W06 K_W15 K_W25 K_U10 K_U11 K_U12 K_K01 K_K04
16.	***LASER SYSTEMS*** *The aim of the course is to familiarize students with the construction and operation of complex laser systems. All the functional elements of the laser system, their role in the system and the principle of operation will be discussed. The focus will be on high energy and high power systems. Currently operating systems and their applications will be presented.*	3.0	AEE	K_W06 K_W07 K_W17 K_U02 K_U05 K_U08 K_K01

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
				K_K08
17.	***ELECTROMAGNETIC PROCESSES IN THE EARTH'S SPACE ENVIRONMENT*** *Remaining of the basic knowledge of electromagnetism. Definition and basic features of the plasma. The atmosphere of the Earth, its structure and dynamics. Solar radiation as a main factor determining the processes in the atmosphere. Global Electric circuit- electromagnetic processes in the neutral atmosphere.. The magnetic field of the Earth, its origin and description. Basic information about Sun its activity and Solar Wind. Magnetosphere of the Earth, its formation and structure. Earth's ionosphere- formation, structure and variability. Disturbances of the magnetosphere and ionosphere its phenomenology, origin and physics. General scheme of the Solar –Earth relations. Space Weather. Propagation of the electromagnetic waves in the space around Earth. The influence of the disturbances in the space on the propagation of the electromagnetic waves, telecommunication, satellite navigation and technology in space and on the ground. Hypothesis about on the influence of the space weather on the human health.*	3.0	AEE	K_W15 K_W22 K_U09 K_K02 K_K04
18.	***SATELLITE OPTICAL INSTRUMENTS*** *Detailed analysis will be presented of selected construction of optical instruments used in spatial missions from the point of view of methodology of work and construction solutions. The basics of the STOP (Structural Thermal and Optical Performance) analysis will be discussed. Practical training will consist on projects of optical systems executed by the students according to set parameters.*	2.5	AEE	K_W02 K_W04 K_W15 K_W24 K_U05 K_U06 K_U11 K_K01 K_K03
19.	***Selected issues of geophysics*** *The programme of the course covers selected issues of modelling geophysical phenomena using satellite observations. It includes:* *1. Structure of the Earth's interior and tectonics of lithospheric blocks.* *2. Earthquakes, seismic waves, physics of earthquakes in the view of recent tectonics.* *3. Structure of the atmosphere, atmospheric refraction, absorption of electromagnetic waves.*	3.5	AEE	K_W15 K_W21 K_W22 K_U04 K_U03
20.	***Mathematical modeling of satellite mechanical subsystems*** *Space missions, types of space experiments, introductory information about space instruments and their tasks. Classification and types of spacecraft and scientific instruments. Environmental and technical requirements for mechanical satellite subsystems. Design processes (including mathematical background) of selected subsystems of spacecraft, in particular: thermal system, satellite structure, mechanisms and navigation system. Procedures for the implementation of thermal, mechanical and radiation tests. New space technologies and directions of space market evolution.*	3.0	AEE	K_W02 K_W04 K_W15 K_W27 K_U05 K_U06 K_U11 K_K01 K_K03
21.	***PHYSICAL BASIS FOR REMOTE -SENSING***	3.0	AEE	K_W15

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	The aim of the course is to present to the students the physical background of remote-sensing methods which are now widely used in practical applications in the exploration of Earth and other planets. The knowledge of physics of phenomena and measurement methods will permit the student to understand and interpret the results of various types of imaging. At the end of the course, the student must be able to independently mathematically describe the physical phenomena occurring during the measurement and to create the simulation algorithm for remote-sensing measurements depending on the characteristics of the tested objects and the measurement geometry.			K_W22 K_U05 K_U06 K_K01 K_K02
22.	***MICRO AND NANO DETECTION*** *The topics of the classes will concern imaging methods in the micro and nanometer scale. The methods of imaging in the visible range of electromagnetic radiation and in the short-wave range with the use of X-rays will be discussed. In addition, methods using electrons as information carriers, as well as methods using short-range interactions, such as tunneling or atomic microscopy, will be presented. The physical principles of operation of imaging systems, measurement methods along with examples of such commercial devices and the possibilities of imaging matter in the micro and nanometer scale will be discussed.*	3.0	AEE	K_W04 K_W06 K_W07 K_W13 K_W15 K_W16 K_W17 K_U05 K_U07 K_U08 K_U10 K_U11 K_U13 KK_01 K_K02 K_K03 K_K07
23.	***APPLICATION OF LASERS IN TECHNOLOGY*** *Types of lasers, elements and optical systems used in material processing - review; examples of lasers in macro and micro processing; laser-matter interaction: Lorentz-Drude model; optical and thermal parameters of materials; reflection and absorption; energy transport; phase changes; plasma shielding; interaction regimes: cw and millisecond regime (stationary and quasi-stationary), nanosecond regime, picosecond regime, femtosecond regime ("cold ablation"); lasers in surface engineering - polishing, engraving, texturing, cladding, shot-peening, coloring, cleaning, direct interference lithography in micro- and nanotechnology - examples of applications; lasers processing of bulk materials - hardening, welding, cutting, drilling, annealing, rapid prototyping and other use of lasers in industry - examples of applications.*	2.0	AEE	K_W06 K_W07 K_W25 K_U02 K_U07 K_U08 K_U13 K_K01 K_K03 K_K06 K-K07 K_K08
24.	***SELECTED MEASUREMENT METHODS OF FAST PROCESSES*** *A scope of classes will concern measurement methods employed for investigation of processes, where changes take place in a time shorter than 1 μs. Advanced methods developed for scientific research, using modern laser and X-ray techniques, will be introduced. Examples of fast processes will be presented together with instruments and methods employed for measurements.*	2.0	AEE	K_W13 K_W16 K_W25 K_U02 K_U05 K_U06 K_U09 K_U13 K_K01 K_K03

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
25.	***MEDICAL APPLICATIONS OF LASER SOURCES*** *Optical properties of biological media. Methods of analyzing the properties of biological structures. Selected methods of optical diagnostics in medicine. Selected methods of laser therapy and their features. Methods of reconstructing the surface geometry of tissues and organs. Interference phenomenon and interferometer systems for medical applications. Nonlinear interactions and applied diagnostic methods.*	2.0	AEE	K_W04 K_W13 K_W14 K_W16 K_W23 K_W25 K_U05 K_U06 K_K07
26.	***DESIGNING SAFETY SYSTEMS*** *The aim of the course is to familiarize students with the issues of designing security systems with the use of technical / optoelectronic means for detection, visualization and monitoring of external areas. The program of the course covers the principles of developing the concept of systems and the final design and cost estimate documentation of integrated systems of critical infrastructure protection. At the same time, students expand their knowledge of the role of a technical expert during the implementation of a security system on examples related to airports, power plants, border areas, etc. Students are familiarized with modern technical protection systems including modern optoelectronic solutions for the protection of external areas.*	2.0	AEE	K_W17 K_W23 K-U02 K_U04 K_K03 K_K04
27.	***VISUAL INFORMATION SYSTEMS*** *The aim of the course is to familiarize students with the key components of modern vision systems and a wide range of their practical use in various types of information systems. Equipment for image acquisition and archiving as well as lighting systems cooperating with them will be discussed. The temporal, spatial, spectral and radiometric aspects of image information acquisition will be presented. Examples of the use of vision systems will also be presented, among others in the area of monitoring, control and measurement solutions or medical imaging diagnostics. As part of the laboratory classes, students will be able to practically configure, run and test simple vision information systems.*	2.0	AEE	K_W04 K_W05 K_W10 K_W11 K_W12 K_W13 K_W14 K_U02 K_U03 K_U04 K_U06 K_U07 K_U08 K_U10 K_U11 K_U12 K_U13 K_U14 K_K01 K_K04 K_K05 K_K06
28.	***BIOMETRIC IDENTIFICATION SYSTEMS*** *The subject aims is to introduce the biometrics as a method of identifying a person. During this subject, students will familiarize with the issues of various biometric features, construction and design of biometric recognition systems with particular emphasis on access control systems and electronic data carriers. As a part of the subject, students will be introduced to the principle of operation and operation of popular biometric techniques and the construction of complex*	2.0	AEE	K_W04 K_W10 K_W23 K_U03 K_U08

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	biometric systems.			
29.	***DESIGNING VIRTUAL REALITY SYSTEMS*** *The aim of the course is to familiarize students with the general principles of designing and selecting programming and hardware components for cyber-physical systems. The possibilities of commercial virtual and augmented reality systems dedicated to mobile and stationary applications will be characterized. Among others, it will be discussed the role of optoelectronic systems in this type of application. The selected development environment will also be characterized, offering the possibility of designing solutions for Windows and Android operating systems. As part of the exercises and laboratory classes, students will be able to select and configure appropriate hardware and software components for a specific type of application.*	2.0	AEE	K_W04 K_W10 K_W11 K_U02 K_U03 K_U04 K_U07 K_U13 K_U14 K_K01 K_K04 K_K05
30.	***PHYSICS OF LASER MATERIALS*** *Interaction of the electromagnetic field with the medium (quantum description). Harmonic disturbance. Electron energy levels of atoms and free ions. Terms and multiplets of rare earth and transition group metal ions. Elements of group theory, group matrix representations. Splitting of jon energy levels in crystal field. Electron - phonon interaction. Energy levels of transition metal ions. Energy transfer between ions in active media. Acoustic vibrations - phonons. Radiation free transitions. Laser properties of selected broadband media (Cr, Ti doped crystals). Energy levels and laser properties of rare earth ions in crystals (four-level media, quasi three-level media). Comparison of laser properties of Er, Yb, Nd, Ho, Tm ions. Utilization of energy transfer processes in erbium lasers. Up-conversion lasers. Quasi 3-level lasers.*	2.0	AEE	K_W02 K_W06 K_W07 K_U05 K_U09 K_U10 K_K01
31.	***LASER OPTICS*** *Fundamentals of laser beams optics: Fresnel ABCD transform, Gaussian beam, ABCD Kogelnik's rule, F-K Andrews's method, Gaussian beam transformation in optical systems, laser diodes beams, selected laser elements. Coherence of laser radiation: temporal and spatial coherence, partially coherent beams, Gauss-Schell beams, propagation of G-S beams in ABCD systems. Measurements of laser beam parameters: diffraction limit of laser beam, beam parameter product, beam quality, M2 parameter, definitions, methods and devices for beam width measurements, methods and devices for M2 parameter measurement. Wavefront sensors. Fundamentals of open resonator theory; self consistent Gaussian beam parameter in round trip of resonator, criteria of resonator stability, eigenvalues, eigenfrequencies, eigenmodes of laser cavity, Fabry-Perot interferometer/resonator. Two mirror resonators, g1-g2 stability scheme. Hermite-Gaussian and Laguerre-Gaussian laser beams. Selected types of resonators. Propagation of laser beams in atmosphere; diffraction, refraction,*	2.0	AEE	K_W17 K_W24 K_U10 K_U11 K_U12 K_U13

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
	absorption, scattering and depolarization. Models of stratified atmosphere. Fundamentals of Kolmogorov theory of atmospheric turbulences. Wandering, coherence spreading, Fried radius, Cn2 parameter, Rytov variance, scintillation index concepts. Propagation of laser beam in turbulent atmosphere. Nonlinear effects. Concepts of adaptive optics. Fundamentals of laser beam combining: basic schemes, techniques, metrics, last advances in the field.			
32.	***REMOTE SENSING EARTH OBSERVATIONS*** *The main goal of the course is to introduce the subject of the Earth observations based on satellite images. Knowledge about the possibilities of using satellite data as well as the basic principles and methods used for data processing will be provided. The thematic scope of the course includes basic information about satellite images (data formats, resolutions), atmospheric correction, examples of applications, methods of land cover forms classification, classification features, principal component analysis, image filtering, time series, automation of classification processes on the example of the 2GLC classification approach and evaluation of the classification results. During the exercises, students will process satellite data.*	2.0	AEE	K_W05 K_W18 K_W20 K_U02 K_U09 K_K01 K_K02 K_K08
33.	***ELECTRONIC SATELLITE SUBSYSTEMS*** *During the lectures the student will learn about the construction of satellites and their main systems. Special attention will be paid to the information concerning the designing and the testing of universal components of satellite platforms i.e. systems relating to the: power supply, communication, orbit control, orientation control, on-board computers and structure. In addition, the students will complete a basic course relating to the designing and testing methods of satellite subsystems and modules for satellite missions.*	3.0	AEE	K_W02 K_W18 K_W19 K_U04 K_U06 K_U07 K_U11 K_K01 K_K03
34.	***MODERN NAVIGATION SYSTEMS*** *The topics will include the GNSS satellite navigations systems and SBAS (Satellite Base Augmentation System) and GBAS (Ground Base Augmentation System)supporting systems. Methods will be discussed of processing GNSS observations. NDB, DME, VOR, ILS air navigation systems will also be presented as well as the COSPAS-SARSAT and AIS (Automatic Identification System)security systems.*	3.0	AEE	K_W18 K_W21 K_U07 K_U10 K_U16 K_K01
35.	***OPTO FIBER OPTIC TECHNOLOGY IN SPACE ENGINEERING*** *Optical fibers and elements of optical optics used in space engineering. Optical communication in outer space. Fiber optic element base for space applications. Photonic communication on spacecraft. Fiber optic sensors for spacecraft monitoring. Monitoring of returning spacecraft upon entry into the Earth's atmosphere.*	2.0	AEE	K_W18 K_U02 K_U17 K_K01 K_K02
Thesis				

No.	Subject group, subject name[5]: brief description (framework programme)	No. of ECTS credits	Field Code	Reference to major-specific outcomes
1.	***PRE-GRADUATE SEMINAR*** *Seminar – discussion on the proposals of thesis topics and forms of implementation of individual tasks.*	**0**	AEE	K_W23 K_U01 K_U02 K_K01
2.	***GRADUATE SEMINAR*** *Principles, procedures and process of graduation, principles of writing diploma theses and basic requirements related to them, copyright issues and respect for copyright, development of schedules, individual presentations of partial solutions of the thesis according to successive task points, assessment of the current progress of the thesis, consultations and substantive assistance.*	**2.0**	AEE	K_W02 K_W03 K_W04 K_W05 K_W23 K_U01 K_U02 K_U06 K_K01 K_K02
3.	***THESIS*** *Selection of a topic for the diploma thesis. Review of the literature on the problem posed and proposing the way(s) in which it can be solved. Carrying out appropriate experiment, review, review and design or design work using available tools and methods. Elaboration of results of work in form of graphs, tables, drawings or a text study. Use by the students of skills acquired during the studies, extension of independent work and self-education skills and ability to solve technical problems. The scope of work to be performed is specified the calendar plan for the completion of the diploma thesis which should be used to monitor the progress of the student's work. The schedule may be modified according to the needs of each individual thesis.*	**20.0**	AEE	K_W02 K_W03 K_W04 K_W05 K_W09 K_W10 K_W12 K_W27 K_U01 K_U02 K_U06 K_K01 K_K02
4.	**Apprenticeship**	**2.0**	AEE	
Total		**90.0**		

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

The verification of the expected learning outcomes achieved by the student occurs primarily at the level of individual learning modules.

The learning outcomes achieved by the student in classes requiring direct participation of academic staff and students are subject to verification in the framework of basic science classes, practical classes (including exercises, laboratory, seminar and project classes) as well as individual tasks and work performed by the student without the participation of the academic teacher.

The verification of the expected learning outcomes takes the form of examinations (oral and written), credits for assessment, credits, on-going answers to review questions, colloquiums and tests, individual studies and interim projects.

The verification of the learning outcomes in the field of social competences occurs during exercises, laboratory, and seminar and project classes as well as through the assessment of the student's actions and attitudes during the work placement.

The assessment of the expected learning outcomes achieved by the student consists on the assessment by the academic staff of the student's level of achievement of the expected learning outcomes.

In the Institute of Optoelectronics it is recommended to use the following levels of achievement of expected outcomes when assessing the student:

Very good grade — is awarded to the student who has achieved the expected learning outcomes at the level of 91-100%.

Good plus grade — is awarded to the student who has achieved the expected learning outcomes at the level of 81-90%.

Good grade — is awarded to the student who has achieved the expected learning outcomes at the level of 71-80%.

Sufficient plus grade — is awarded to the student who has achieved the expected learning outcomes at the level of 61-70%.

Sufficient grade — is awarded to the student who has achieved the expected learning outcomes at the level of 51-60%.

Insufficient grade — is awarded to the student who has achieved the expected learning outcomes at the level equal or lower than 50%.

General credited grade — is awarded to the student who has achieved the expected learning outcomes at the level higher than 50%.

General non-credited grade — is awarded to the student who has achieved the expected learning outcomes at the level equal or lower than 50%.

Plan of Studies - appendix no. 1

Wojskowa Akademia Techniczna im. Jarosława Dąbrowskiego

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

SCIENCIFIC FIELD: AUTOMATICS, ELECTRONICS AND ELECTRO-TECHNOLOGY

MAJOR: OPTOELECTRONICS

Effective from the academic year 2022-2023

	SUBJECT GROUPS / SUBJECTS	Scientific field	Total no. of hours/ ECTS credits		ECTS / science skills development	ECTS part of academic	Including					Number of hours / evaluations / ECTS credits per semester						Organisational unit administering the course
												I		II		III		
			hours	ECTS			lecture	tutorial	laboratory	project	seminar	hours	ECTS	hours	ECTS	hours	ECTS	
	A. General Subjects		64	5	2	3	36	28				64	5					
1	*Communication and Fundamentals of Negotiations*		30	2.5		1.5	16	14				30 +	2.5					WCY
2	*Selected Topics in Psychology*		30	2.5		1.5	16	14				30 +	2.5					WCY
3	*Occupational Health and Safety*		4				4					4 +						BHP
	B. Core Subjects		134	9.5	1.5	6	68	38	28			104	7.5	30	2			
1	*Mathematical Analysis*	AEE	60	4		3	30	30				60 ×	4					WCY
2	*Calculus of Probabilities and Mathematical Statistic*	AEE	44	3.5		2	24	8	12			44 +	3.5					WCY
3	*Numerical Methods*	AEE	30	2	1.5	1	14		16					30 +	2			IOE
	C. Major Subjects		416	28.5	18.5	15	214	96	96		10	272	17.5	144	11			
1	*Optics*	AEE	60	4	2	2	32	16	12			60 ×	4					IOE
2	*Fundamentals of Quantum Electronics*	AEE	60	3.5	2	2	40	12	8			60 ×	3.5					IOE
3	*EM Radiation Sources*	AEE	60	3.5	2	2	34	14	12			60 ×	3.5					IOE
4	*Optoelectronic Materials Science & Technology*	AEE	60	3.5	2	2	30	18	12			60 ×	3.5					IOE
5	*Basics of Designing Optical Systems*	AEE	32	3	2	1.5	14	14	4			32 +	3					IOE
6	*Detectors of Optical Radiation*	AEE	50	4	3	2	26	8	16					50 ×	4			IOE
7	*Thermovision and Infrared Technology*	AEE	50	3.5	3	2	22	8	20					50 ×	3.5			IOE
8	*Fibre Optic Technology*	AEE	44	3.5	2.5	1.5	16	6	12		10			44 ×	3.5			IOE
	D. Elective Subjects		300	23	18	11								190	15	110	8	
1	*Programmable Logic Devices*	AEE	46	3	3	1.5	22		24					46 +	3			IOE
2	*Optoelectronic Measurement*	AEE	30	3	1.5	1	14	4	12					30 +	3			IOE
3	*Laser Technology*	AEE	60	4	4	2	24	10	16		10			60 ×	4			IOE
4	*Multi and Hyperspectral Imaging Systems*	AEE	40	3	2.5	1.5	14	4	12		10			40 +	3			IOE
5	*Terahertz Systems*	AEE	40	3	2.5	1.5	14		16		10			40 +	3			IOE
6	*Spectroscopy and Optical Imaging in Material Research*	AEE	40	3	2.5	1.5	14	8	8		10			40 +	3			IOE
7	*Photovoltaics Systems and Devices*	AEE	40	3	2.5	1.5	14	8	8		10			40 +	3			IOE
8	*Laser Communication Systems*	AEE	40	3	2.5	1.5	14	8	8		10			40 +	3			IOE
9	*Security Systems Operation and Use*	AEE	30	2	1.5	1	18	12						30 +	2			IOE
10	*Optoelectronics Monitoring of Infrastructure*	AEE	30	2	1.5	1	12	6	12					30 +	2			IOE
11	*Optoelectronics in Security Systems*	AEE	30	2	1.5	1	10	8	12					30 +	2			IOE
12	*Processing and Analysis of Images*	AEE	40	4	2.5	1.5	10	14	16					40 +	4			IOE
13	*Virtual Reality Technologies*	AEE	30	2	1.5	1	14		16					30 +	2			IOE
14	*Non-linear Optical Conversion of Laser Radiation*	AEE	30	3	2	1	14	10	6					30 +	3			IOE
15	*Application of High Power Pulsed Laser*	AEE	30	2	1.5	1	14	2	12		2			30 +	2			IOE
16	*Laser Systems*	AEE	30	3	1.5	1	14		8		8			30 +	3			IOE
17	*Electromagnetic Processes in the Earth's Space Environment*	AEE	40	3	2.5	1.5	40							40 +	3			CBK
18	*Satellite Optical Instruments*	AEE	30	2.5	1.5	1	20	10						30 ×	2.5			CBK
19	*Selected Issues of Geophysics*	AEE	50	3.5	2.5	1.5	16	18			16			50 ×	3.5			WIG
20	*Mathematical Modeling of Satelite Mechanical Subsystems*	AEE	40	3	2.5	1.5	15		10	15				40 +	3			CBK
21	*Physical Basis for Remote Sensing*	AEE	40	3	2.5	1.5	30	10						40 +	3			CBK
22	*Micro and Nano Detection*	AEE	40	3	2.5	1.5	20	8	12							40 +	3	IOE
23	*Application of Lasers in Technology*	AEE	36	2	2	1	20	4	12							36 +	2	*IOE*
24	*Selected Measurement Methods of Fast Processes*	AEE	30	2	2	1	16		12		2					30 +	2	IOE
25	*Medical Applications of Laser Sources*	AEE	30	2	2	1	15	6	9							30 +	2	IOE
26	*Designing Safety Systems*	AEE	30	2	1.5	1	14		16							30 +	2	IOE
27	*Visual Information Systems*	AEE	30	2	1.5	1	14		16							30 +	2	IOE
28	*Biometric Identification Systems*	AEE	30	2	1.5	1	16		14							30 +	2	IOE
29	*Designing Virtual Reality Systems*	AEE	30	2	1.5	1	10	4	16							30 +	2	IOE
30	*Physics of Laser Materials*	AEE	30	2	1.5	1	16	10	4							30 +	2	IOE
31	*Laser Optics*	AEE	32	2	1.5	1	16	8	8							32 +	2	IOE
32	*Remote Sensing Earth Observations*	AEE	40	3	2.5	1.5	20		20							40 +	3	CBK
33	*Electronic Satellite Subsystems*	AEE	20	2	2.5	1.5	10		10							20 +	2	CBK
34	*Modern Navigation Systems*	AEE	22	3	2.5	1.5	10		12							22 +	3	WIG
35	*Opto Fiber Optic Technology in Space Engineering*	AEE	30	2	1.5	1	16		14							30 +	2	IOE
	E. Thesis		26	22	18	11.5					26	6				20	22	
1	*Pre Graduate seminar*	AEE	6		0.5	0.5					6	6 +						IOE
2	*Graduation seminar*	AEE	20	2	1.5	1					20					20 +	2	IOE
3	*Thesis*	AEE		20	16	10											20	IOE
	F. Apprenticeship	*no. of weeks*		2	2	1	*lead time*								2			
1	*Apprenticeship*	AEE	≥ 2	2	2	1	*after second semester*							+	2			IOE
	Total number of hours / ECTS credits		940	90	60	47.5						446	30	364	30	130	30	
	Acceptable deficit of ECTS credits											16		10				
	Type and number of required evaluations								number of exams - x			5		max. 5				
									number of assesments - +			5		max. 5		max. 5		
									number of projects - #					max. 1				

Opinia rady ds. kształcenia
Instytutu Optoelektroniki
Wojskowej Akademii Technicznej
z dnia 15 grudnia 2021 r.
nr 14/RdsK/IOE/2021

w sprawie projektu programu studiów II-go stopnia dla kierunku optoelektronika 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 (tj. obwieszczenie Rektora WAT nr 1/WAT/2021 z dnia 21 października 2021 r. w sprawie ogłoszenia jednolitego tekstu uchwały w spawie uchwalenia Statutu WAT).

Rada ds. kształcenia Instytutu Optoelektroniki wyraża pozytywną opinię w sprawie projektu programu studiów II-go stopnia dla kierunku optoelektronika obowiązującego od roku akademickiego 2022/2023, prowadzonych w języku angielskim.

Przewodniczący rady ds. kształcenia

dr inż. Mirosław Szczurek