Lodz University of Technology

Study programme

Faculty:	Faculty of Technical Physics, Information Technology and Applied Mathematics
Major:	Technical Physics
Level of study:	first-cycle programme (inżynier)
Form of study:	full-time studies
Academic year:	2026/27

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Basic information

Name of the field of study:	Technical Physics
Level of study:	first-cycle programme (inżynier)
Study profile:	general academic
Form of studies:	full-time studies
Duration of studies (number of semesters):	7
The number of ECTS points required to complete studies:	210
Total number of hours of classes:	2725
The number of ECTS points a student obtains as part of classes conducted with the direct participation of academic teachers or other persons conducting classes:	109
Professional title awarded to graduates:	inżynier
ISCED code:	0533
Language of study:	polish

Assigning the course to the disciplines to which the learning outcomes relate

Discipline	Percentage share
Physical sciences	100%

Learning outcomes (in relation to the PQF)

No.	Learning outcome code	Learning Outcome Content	Reference to the universal characteristics of the first level of PRK	Reference to the second-level characteristics of the PRK, taking into account the second-level characteristics enabling the acquisition of engineering competences
1	**1FZT1**	Possesses knowledge and understands the fundamental and advanced laws of classical and modern physics, including selected aspects of quantum physics, optics, photonics, optoelectronics, and nuclear engineering, which underpin the mathematical description of phenomena applied in physics and modern technologies.	P6U_W	P6S_WG
2	**1FZT2**	Possesses knowledge of the fundamental legal, economic, and ethical aspects of responsible knowledge use and professional practice in physics; understands the key challenges of contemporary civilization; is familiar with basic concepts of industrial property protection and copyright; and considers the life cycle of devices when evaluating technical solutions and their environmental and societal impact.	P6U_W	P6S_WK
3	**1FZT3**	Possesses knowledge and understands modeling and computer simulation methods applied in the analysis of physical phenomena, with particular emphasis on numerical methods for solving selected differential equations.	P6U_W	P6S_WG
4	**1FZT4**	Possesses knowledge of the principles governing measurement apparatus and methods for the analysis and processing of experimental data, including the assessment of measurement uncertainties and the validation of models.	P6U_W	P6S_WG
5	**1FZT5**	Is able to solve complex and non-standard problems by creating and analyzing models of physical systems, applying selected mathematical methods for their analytical solutions, and using advanced computer software for their numerical simulations.	P6U_U	P6S_UW
6	**1FZT6**	Is able to design and carry out physical experiments: plan and organize teamwork, perform measurements, and process and interpret results in order to formulate conclusions based on experimental data.	P6U_U	P6S_UO
7	**1FZT7**	Is able to independently plan and pursue personal development by integrating knowledge from various branches of physics necessary for conducting critical analysis and solving selected engineering problems using analytical and numerical methods.	P6U_U	P6S_UW, P6S_UU
8	**1FZT8**	Is able to communicate effectively in both their native language and a foreign language at the B2 level, and to prepare technical documentation, reports, or presentations concerning models, research, or engineering projects, while presenting results clearly and professionally in the chosen language.	P6U_U	P6S_UK, P6S_UO
9	**1FZT9**	Is ready to work in interdisciplinary and international teams, demonstrating responsibility, integrity, and collaborative skills, actively contributing to shared objectives, and respecting the diversity of experiences and viewpoints of team members.	P6U_K	P6S_KK, P6S_KR

No.	Learning outcome code	Learning Outcome Content	Reference to the universal characteristics of the first level of PRK	Reference to the second-level characteristics of the PRK, taking into account the second-level characteristics enabling the acquisition of engineering competences
10	**1FZT10**	Is prepared to act entrepreneurially and demonstrates awareness of professional ethics in the application of physics-based knowledge, considering social, legal, and environmental factors, and undertaking actions that are responsible toward society and the environment.	P6U_K	P6S_KO, P6S_KR

Matrix of course modules in relation to learning outcomes and curriculum content

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
1	Fundamentals of Physics	Operations on vectors, kinetics in Cartesian and in radial system, fundamentals of special theory of relativity, Newton's laws of motions, real and apparent force, principles of conversation, conservative and non-conservative forces, fluid and air static and dynamic, basic of gravity, basic od rigid body dynamic, elements of relativistic dynamic, foundations of macroscopic thermodynamics, basic thermodynamic functions and potentials as well as the 0th, the 1st and the 2nd law of thermodynamics. heat engines a, the model of an ideal gas and van der Waals equation and virial equation.	x				x					
2	Elements of Mathematical Analysis I	The field of real numbers, elementary functions, numerical sequences and their convergence, limits of functions, continuity and differentiability of real functions of a single real variable, analysis of the behavior of functions, applications of selected theorems of differential calculus in mathematics and physics. Antiderivatives of real functions of a single real variable and selected methods of finding them, the indefinite and definite integral of a real function of a single real variable, selected applications of the integral in mathematics and physics, convergence of improper integrals. Numerical series — examination of convergence using methods of differential and integral calculus.	x				x					
3	Algebra with Analytic Geometry I	Basics of general algebra, field of complex numbers, matrices and determinants, systems of linear equations, elements of analytic geometry, linear spaces.	x				x					
4	Experimental Data Analysis I	Notions of measurement and experiment, rules for planning scientific research, logics of experiment and reasoning, basics of statistics, data analysis and data presentation.				x						
5	Intellectual Property Protection	Introduction, organizational matters, discussion of the importance of intellectual property protection in international, European, and national law. International agreements and European conventions in the field of industrial property. Selected issues related to the protection of industrial property in Poland. Basic principles of the patent system. Basic principles of preparing a patent description. Introduction to searching patent databases. Principles of applying creative thinking. Introduction to the management of protected knowledge.		x						x		x
6	Teamwork	Introduction to teamwork, team roles, communication within a team, organizing team workflows, resolving team conflicts, motivation and engagement, team leadership, creativity and innovation in teamwork, team performance evaluation, practical aspects of teamwork.						x			x	
7	Information Technologies I	Data protection, archiving, encryption, cloud data. Microsoft Office applications in professional use. Basics of the Internet and local area networks. Security and privacy issues on the Internet. Optional topics: Fundamentals of virtualization, fundamentals of using artificial intelligence tools.		x				x		x		
8	Vibrations and Waves	Fundamentals of mathematical description of harmonic vibrations. Phenomena in vibrating systems. Wave equation and resulting wave properties. Application of the introduced apparatus in physical systems.	x				x					
9	Electricity and Magnetism	Electric field in vacuum and matter, electric current, magnetic field in vacuum and matter, DC and AC circuits, introduction to the electromagnetic field.	x				x					

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
10	Elements of Mathematical Analysis II	Functional sequences and series (including power series, Taylor series expansion of a function), convergence criteria, types of convergence. Continuity and differentiability of functions of several variables, determination of local and global extrema (on simple compact sets). Multiple integrals and methods of computation (iterated integrals, Fubini's theorem), curvilinear integral and methods of computation (Green's theorems), and interpretations in mathematics and physics. Ordinary differential equations (at least the following types: separable equation, homogeneous equation with respect to the quotient y/x, first- and second-order linear equation, exact equation), solution methods, and interpretation of solutions.	x				x					
11	Algebra with Analytic Geometry II	Linear algebra topics relevant to physics, covering matrices, vector spaces, and mappings between them.	x				x					
12	Information Technologies II	Basics of programming in Python. Creating algorithms and implementing them on a computer. Creating a programme that solves a given physical problem.			x		x					
13	Experimental Data Analysis II	Notions of a random variable, population and sample. Representative sample. Discrete and continuous probability distributions. Parameters of a distribution. Statistical hypotheses and tests. Level of significance. Methods of interpolation, extrapolation, estimation and approximation. Outliers and ways of detecting them. Analysis of variance and covariance.				x						
14	Scientific Seminar I	Familiarization is provided with the principal research areas conducted at the Institute of Physics of Lodz University of Technology. An overview is presented of the scientific research groups operating within the Institute, with emphasis on the scope, methodologies, and thematic orientation of their academic activities. A research group (together with an academic supervisor) is to be selected, within which a minor research assignment will be carried out during the forthcoming academic year.										x
15	English B2 module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
16	English B2+ module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
17	English C1 module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
18	German B2 module I	The first part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
19	Experimental Physics I	Practical mastering of basic measurement methods and acquisition of basic skills in laboratory practice in the course of self-conducted (or team-based) series of experiments in the field of classical physics, in particular mechanics, thermodynamics and electricity.						x				
20	Introduction to Modern Physics	An overview is provided of the landmark experiments that marked the emergence of atomic physics and quantum physics, together with the principal conclusions derived from these studies. The fundamentals of the theory of relativity and its impact on classical concepts in kinematics and dynamics are discussed. Further topics include the structure of the atom, the quantum theory of light, wave–particle duality, the foundational principles of quantum physics, and the organization of the periodic table of elements.	x				x					
21	Theoretical Mechanics	Constraints, motion of constrained systems. Configuration space, d'Alembert's principle for a system of point-like particles. Lagrange equations of the first kind. Generalized coordinates, Lagrange equations of the second kind. Generalized momentum, cyclic coordinates, invariants of the Lagrange equations of the second kind. Hamilton's principle. Hamilton's equations. Poisson brackets.	x				x					
22	Open Source Software	Open source tools for scientific and engineering applications (including LaTeX and basic Unix terminal operations).						x		x		
23	Basics of Programming	Programming in C++ for calculating physical quantities, solving differential equations (e.g., using the simple iteration method), and modeling physical processes such as the free and forced harmonic oscillator.			x		x					
24	Differential Equations in Physics I	The most physically important ordinary differential equations and methods used to solve them. Basic methods of analyzing ordinary differential equations using computer algebra software.	x		x		x					
25	Geometrical and Physiological Optics	The fundamentals of geometric and physiological optics are presented in the context of technical applications. The laws governing the rectilinear propagation of light, reflection, and refraction, as well as the principles of image formation in optical systems, are discussed. The structure and operation of optical elements such as lenses and mirrors, along with their use in optical instruments, are analyzed. In the physiological part, the functioning of the visual system, the processes of image formation on the retina, and the limitations and characteristics of visual perception are presented. Selected issues related to visual impairments and methods of their correction are also included.	x			x		x			x	
26	Photography	Fundamentals of photography with particular emphasis on its applications in technical sciences and engineering practice. The construction of cameras, the principles of image recording, and the parameters affecting image quality are discussed. The basic laws of optics used in photographic techniques are presented, with particular emphasis on the role of light, lenses, photosensitive sensors, and optical system components.	x							x		x
27	English B2 module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
28	English B2+ module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
29	English C1 module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
30	German B2 module II	The second part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
31	Experimental Physics II	The use of students' theoretical and practical knowledge acquired in the course of studies to conduct measurements in accordance with safety regulations, employing various methods of analysis and presentation of results. Experimental determination of selected physical quantities in the course of self-conducted (or team-based) series of experiments in the field of modern physics.						x				
32	Engineering Documentation and Graphics	Introduction to technical drawing, drawing sheet formats, and computer graphics recording methods. The AutoCAD interface and basics. Precision drawing in AutoCAD. Basic plane structures. Working with layers and blocks. Dimensioning technical drawings, creating and editing dimension styles. Technical writing. Introduction to printing technical documentation.						x	x	x		
33	Numerical Methods of Computational Physics I	Numerical calculation errors. Approximation and interpolation. Numerical integration and differentiation. Finding minima, maxima, and roots of single- and multi-variable functions. Solving systems of equations. Solving ordinary differential equations. Solving partial differential equations (optional topic). Use of programming tools in the software development process. Basic methods of working in a programming environment, as well as practical aspects of code development and analysis.			x				x	x		
34	Scientific Seminar II	A presentation is provided of the research outcomes achieved by selected scientific teams of the Institute of Physics of Lodz University of Technology during the preceding year.								x		
35	Nuclear Technique	Discussion of the structure of the atomic nucleus, nuclear models, nuclear decays, nuclear reactions, ionizing radiation, and the applications of these phenomena in technology. Practical mastery of basic methods of detecting ionizing radiation, as well as the acquisition of fundamental skills and good laboratory practices involving the use of ionizing radiation sources.	x	x		x	x	x			x	

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
36	Liquid Crystals	The basic physical properties of nematic, cholesteric, and ferroelectric smectic liquid crystals are discussed. Liquid-crystal textures, chemical structure, molecular orientational order, and the anisotropy of their properties are presented. The elastic, magnetic, electric, optical, dielectric, and flexoelectric properties of liquid crystals are analyzed. Elements of the molecular field theory, issues related to disclinations, the hydrodynamics of nematics, interactions with solid surfaces, and the influence of space charge on deformations and electrohydrodynamic phenomena are introduced. Applications of liquid crystals in information display technologies, photonics, thermography, and the chemical industry are also included.	x				x	x			x	
37	Scientific Results Presentation	Forms of Presenting Scientific Results with an Emphasis on the Exact Sciences. LaTeX and Open-Source Software for Creating Presentations. Technical aspects of creating slides and giving oral presentations.	x				x	x			x	
38	Introduction to Quantum Mechanics	Mathematical foundations of the Hilbert space quantum mechanics. Physical examples: free particle, particle in an infinite well, harmonic oscillator, angular momentum.	x				x					
39	Mathematical Foundations of Quantum Systems	Quantum Mechanics in finite dimensional Hilbert spaces. Spin.	x				x					
40	English B2 module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
41	English B2+ module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
42	English C1 module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
43	German B2 module III	The third part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
44	Electrodynamics	Laws of electrostatics and magnetostatics in vacuum and material media, including analysis of potentials and field energy. Dynamics of electromagnetic systems based on Maxwell’s equations, propagation of electromagnetic waves.	x				x					
45	Solid State Physics	Crystal lattice, crystal symmetries, types of crystal bonds, vibrations of crystal lattice, models of electrons in crystals, and properties of semiconductors. Solving problems on selected lecture topics.	x				x					
46	Electronics and Electrical Engineering in Physical Research	Fundamental laws of electrical engineering. RLC elements. Diode and bipolar transistor - types and characteristics. Operational amplifier and its applications. Description and analysis of selected electrical and electronic circuits.	x									

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
47	Numerical Methods of Computational Physics II	Familiarization is provided with the Finite Element Method (FEM), which is used for the numerical solution of partial differential equations. The course includes the practical execution of a project assignment, such as developing a computer program employing the FEM and using it to simulate selected physical phenomena, for example heat distribution or electric current flow in model physical systems.			x							
48	Selected Topics in Chemistry	Selected topics in general and organic chemistry relevant to technical physics. The nature of chemical bonding, molecular structure within the framework of quantum mechanics (Schrödinger picture), the energetics of chemical processes including the fundamentals of thermochemistry, as well as chemical equilibrium and reaction kinetics enabling a quantitative description of processes. Fundamentals of electrochemistry and the characteristics of selected classes of organic compounds, with emphasis on their properties and industrial applications.	x									x
49	Microscopic Thermodynamics and Statistical Mechanics	Axiomatic formulation of thermodynamics. Statistical physics of systems in equilibrium. Quantum distribution functions. Fluctuations. The Boltzmann kinetic equation.	x				x					
50	Microscopic Thermodynamics and Statistical Mechanics	Geometric attempt to thermodynamics. Systems in total equilibrium. Quantum distributions: Bose - Einstein and Fermi - Dirac.	x				x					
51	Mathematical Methods in Physics	Variational calculus with applications to physics. Fundamentals of complex analysis.	x				x					
52	Experimental Physics III	Practical mastery of advanced fundamental measurement methods and the acquisition of advanced essential skills and habits of laboratory practice during independently (or collaboratively) conducted series of physics experiments.	x				x					
53	English B2 module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
54	English B2+ module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
55	English C1 module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		
56	German B2 module IV	The fourth part of a business language course with elements of industry-specific terminology; development of all language skills; development and improvement of soft skills oriented around the future working environment of the university graduate.								x		

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
57	Electronics Laboratory	Fundamentals of semiconductor devices and selected electronic circuits. Students will develop skills in using electronic measuring instruments. Students will develop practical skills in building, testing, and analyzing the operation of selected electronic circuits.				x		x		x		
58	Differential Equations in Physics II	Several methods of solving partial differential equations in technique and physics.	x		x		x					
59	Lasers and Their Selected Applications in Physics	Classification of lasers, principles of operation and construction of selected gas lasers, properties of laser radiation and its propagation in anisotropic media. Measurements of selected optical and electrooptical properties of samples using laser light.	x					x				
60	Optoelectronics	Familiarization is provided with the structure and fundamental operating principles of selected contemporary optoelectronic devices. Particular emphasis is placed on the physical phenomena occurring during the operation of these devices and determining their functional characteristics. The course includes the design and/or numerical simulation of a selected semiconductor device with specified operating parameters.	x				x					
61	Solid Crystals	The structure, properties, and significance of crystalline solids in physics and engineering. The description of crystal structures, symmetry principles, and the periodic arrangement of matter on the atomic scale is discussed. Fundamental concepts of crystallography essential for understanding the properties of crystalline materials are presented.	x			x		x			x	
62	Engineering Project I	A research and design project on a selected topic in the field of technical physics, related to research conducted at the Institute of Physics, or the implementation of an engineering project on a specified subject. The course aims to develop the ability to independently solve scientific and technical problems, plan and conduct experimental, computational, or simulation-based studies, and present the results in the form of a coherent engineering or research report.		x				x		x	x	x
63	Digital Technology	Boolean algebra and logic gates, combinational and sequential logic circuits, numbers encoding, basic functional blocks of digital devices, and an introduction to a selected family of microcontrollers. Design of logic circuits and programming of microcontrollers.						x	x			
64	Optical Microscopy	Fundamentals of optical microscopy and its applications in technical sciences. The construction and operating principles of optical microscopes, including illumination and imaging systems, are discussed. The physical phenomena underlying the formation of the microscopic image—such as reflection, refraction, diffraction, and interference—are analyzed. Methods for improving spatial resolution and techniques for enhancing image contrast are presented.	x			x		x		x		
65	History of Physics	Development of the physical sciences from antiquity and the Middle Ages, through the rise of modern science, to the consolidation of the classical branches of physics in the nineteenth century. Evolution of fundamental concepts and methodological approaches in mechanics, optics, thermodynamics, as well as electricity and magnetism.	x									
66	Final Project	Acquiring professional skills and social competencies in an environment appropriate for future professional activity. Expanding knowledge acquired during studies and developing the ability to apply it in practice.		x				x	x			x

No.	Course name	Program content	1FZT1	1FZT2	1FZT3	1FZT4	1FZT5	1FZT6	1FZT7	1FZT8	1FZT9	1FZT10
67	Internship	Acquiring professional skills and social competencies in an environment appropriate for future professional activity. Expanding knowledge acquired during studies and developing the ability to apply it in practice.						x				x
68	Diploma Seminar	Enhancement of the substantive content related to the engineering diploma thesis in the field of technical physics and the key learning outcomes in this area. Development of skills in presenting research results and public speaking through the presentation of selected parts of the diploma thesis. Discussion of selected topics preparing students for the competency examination.		x				x	x	x		x
69	Engineering Project II	A research and design project on a selected topic in the field of technical physics, related to research conducted at the Institute of Physics, or the implementation of an engineering project on a specified subject. The course aims to develop the ability to independently solve scientific and technical problems, plan and conduct experimental, computational, or simulation-based studies, and present the results in the form of a coherent engineering or research report.		x				x		x	x	x
70	Selected Topics in Molecular Physics	Introduction to molecular physics, including molecular orbital theory and elements of molecular spectroscopy.	x									
71	Methods for Describing Electronic	Introduction to the theory of atomic (AO) and molecular orbitals (MO), including the LCAO method and the concepts of bonding, antibonding, and nonbonding orbitals, with emphasis on the role of symmetry and comparison with the hybridization concept. The Hamiltonian of a many-electron system and the Born–Oppenheimer approximation as the basis for describing molecular electronic structure. The Hartree–Fock method and the solution of self-consistent field equations in an atomic orbital basis. Fundamentals of density functional theory (DFT).	x		x		x					

ECTS - subjects

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
1	Fundamentals of Physics	9			9	
2	Elements of Mathematical Analysis I	6			6	
3	Algebra with Analytic Geometry I	5			5	
4	Experimental Data Analysis I	3			3	
5	Intellectual Property Protection	2	2			
6	Teamwork	2		2		
7	Information Technologies I	3				
8	Vibrations and Waves	5			5	
9	Electricity and Magnetism	5			5	
10	Elements of Mathematical Analysis II	6			6	
11	Algebra with Analytic Geometry II	5			5	
12	Information Technologies II	3				
13	Experimental Data Analysis II	3			3	
14	Scientific Seminar I	1				
15	English B2 module I	2		2		
16	English B2+ module I	2		2		
17	English C1 module I	2		2		
18	German B2 module I	2		2		
19	Experimental Physics I	3			3	
20	Introduction to Modern Physics	5			5	
21	Theoretical Mechanics	5			5	

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
22	Open Source Software	3				
23	Basics of Programming	4				
24	Differential Equations in Physics I	5			5	
25	Geometrical and Physiological Optics	3		3		
26	Photography	3		3		
27	English B2 module II	2		2		
28	English B2+ module II	2		2		
29	English C1 module II	2		2		
30	German B2 module II	2		2		
31	Experimental Physics II	4			4	
32	Engineering Documentation and Graphics	2			2	
33	Numerical Methods of Computational Physics I	8			8	
34	Scientific Seminar II	3				
35	Nuclear Technique	3				
36	Liquid Crystals	4		4		
37	Scientific Results Presentation	4		4		
38	Introduction to Quantum Mechanics	4		4		
39	Mathematical Foundations of Quantum Systems	4		4		4
40	English B2 module III	2		2		
41	English B2+ module III	2		2		
42	English C1 module III	2		2		
43	German B2 module III	2		2		

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
44	Electrodynamics	4			4	
45	Solid State Physics	4			4	
46	Electronics and Electrical Engineering in Physical Research	4			4	
47	Numerical Methods of Computational Physics II	4			4	
48	Selected Topics in Chemistry	2				
49	Microscopic Thermodynamics and Statistical Mechanics	5		5		
50	Microscopic Thermodynamics and Statistical Mechanics	5		5		5
51	Mathematical Methods in Physics	4		4		
52	Experimental Physics III	4		4		
53	English B2 module IV	3		3		
54	English B2+ module IV	3		3		
55	English C1 module IV	3		3		
56	German B2 module IV	3		3		
57	Electronics Laboratory	4			4	
58	Differential Equations in Physics II	4			4	
59	Lasers and Their Selected Applications in Physics	2			2	
60	Optoelectronics	4			4	
61	Solid Crystals	2			2	
62	Engineering Project I	10	10	10		
63	Digital Technology	4		4		
64	Optical Microscopy	4		4		
65	History of Physics	2	2			2

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
66	Final Project	15		15		
67	Internship	6				
68	Diploma Seminar	2				
69	Engineering Project II	3		3		
70	Selected Topics in Molecular Physics	2		2		
71	Methods for Describing Electronic	2		2		

ECTS indicators

Name	Value
The total number of ECTS credits that a student must obtain through elective courses (amounting to no less than 30% of the total ECTS credits required to obtain the qualification corresponding to the given level of study)	65/210 (30.95%)
The total number of ECTS credits to be earned by a student through courses in the fields of humanities or social sciences	14
The total number of ECTS credits that a student must obtain from courses related to research conducted at the university, amounting to more than 50% of the total ECTS credits required to graduate from a given level of study	111/210 (52.86%)

Methods of verifying and assessing learning outcomes

The verification of learning outcomes achieved in the Technical Physics programme requires the use of diverse assessment methods, appropriate to the categories of outcomes covering knowledge, engineering and laboratory skills, and social competencies. The selection of verification methods depends on the specifics of a given course, the type of classes (lectures, laboratories, projects, problem-solving classes, specialized laboratories), and is specified in each course syllabus.

The achievement of the required learning outcomes is verified through:

· written work – exams, mid-term tests, laboratory reports, computational projects, as well as the diploma thesis,

· oral assessments – oral examinations, presentations of research and project results, report defences, and presentations on physical and technical topics,

· practical or project-based tasks – both individual and team-based, including laboratory measurements, operation of equipment, analysis of experimental data, computer modelling, and design of optical or electronic system components,

· observation and evaluation of student activity during classes – particularly in laboratories, problem-solving sessions, project work, and simulation classes,

· self-assessment and peer assessment – especially in team projects, where cooperation, technical communication, and responsibility for joint outcomes are important,

· a specific form of learning outcome verification is the competency examination and the diploma examination, which include assessment of subject-specific knowledge, practical engineering skills, and the ability to present conducted research or an engineering project.

Verification may be formative (ongoing, partial assessment during the course) and/or summative (final evaluation).

The final result of the assessment is expressed using the currently applicable grading scale, in accordance with the Study Regulations of Lodz University of Technology.

Professional internships

The professional internship in the Applied Physics programme lasts 6 weeks. The rules and forms of completing the internship are regulated by the applicable Ordinance of the Rector of Lodz University of Technology (currently Ordinance No. 66/2021 of 29 October 2021). Upon successful completion of the internship, the student is awarded 6 ECTS credits.

Characteristics of the course

Graduate profile

A graduate of Technical Physics is a versatile specialist who combines a strong foundation in physics and mathematics with engineering competencies, enabling the design and analysis of modern technological solutions. Through the study of fundamental principles governing the physical world, the graduate is capable of understanding, modelling, and predicting the behaviour of complex systems—from nanostructures and functional materials to electronic, photonic, energy, and quantum systems.

Competencies and Skills

A graduate of the programme:

· Possesses in-depth knowledge of mechanics, thermodynamics, electromagnetism, optics, computer science, and applied mathematics, enabling effective solving of engineering and technological problems.

· Demonstrates analytical, critical, and creative thinking—trained to challenge established patterns, decompose problems into fundamental components, and construct precise physical and mathematical models.

· Is proficient in programming, conducting computer simulations, and using computational tools to optimise technological processes and design new solutions.

· Is capable of designing and analysing photonic and electronic devices, automation systems, prototypes, and measurement equipment, as well as proposing innovative materials and nanostructures with desired properties.

· Understands the principles of quantum engineering, photonics, acoustics, fluid mechanics, and materials physics, enabling the development of future technologies—from quantum systems to energy-efficient and low-emission solutions.

· Possesses interdisciplinary competencies—integrating physics, mathematics, engineering, computer science, and data analysis, which allows for a multidimensional approach to problem-solving and the development of solutions beyond traditional engineering frameworks.

Attitudes and Professional Preparation

A graduate of Technical Physics is characterised by intellectual flexibility, a high level of analytical culture, and the ability to rapidly assess information. The graduate is prepared for:

· work in innovation-driven environments,

· conducting experiments and research and development projects,

· effective collaboration in technical and interdisciplinary teams,

· making decisions based on data, modelling, and reliable analysis.

The ability for multidimensional thinking, developed during physics studies, also predisposes the graduate to roles requiring strategic planning and a comprehensive understanding of complex systems.

Thanks to interdisciplinarity and the ability to integrate knowledge from various fields, a graduate of Technical Physics is not only a technology specialist but may also become an innovator, project leader, or a creator of new directions for development in industry, the economy, and science.

The relationship between the field of study and the university's strategy

The education of students in the Technical Physics programme is fully aligned with the mission and strategy of Lodz University of Technology, which focus on educating highly qualified specialists, conducting research with strong innovation potential, and strengthening cooperation with the socio-economic environment. The study programme has been developed in response to current needs of the national and regional economy, particularly in sectors utilizing advanced technologies, modern materials, electronics, photonics, and solutions based on quantum physics. The demand in the labour market for graduates with interdisciplinary competencies combining physics, engineering, and computer science is confirmed by consultations with employers and partners cooperating with the

Faculty.

The Faculty of Technical Physics, Information Technology and Applied Mathematics provides students with conditions for comprehensive development, enabling them to acquire the knowledge, skills, and competencies necessary to work in high-tech, research and development, and engineering sectors. The Faculty actively cooperates with business partners, industrial entities, and research centres, which is directly in line with the strategic priority of Lodz University of Technology to strengthen its impact on the socio-economic environment. Joint project initiatives and programme consultations allow for continuous updating of educational content and its adaptation to the dynamically changing technology market.

The educational concept of the Technical Physics programme is based on the strong scientific and teaching potential of the Faculty, which holds an A scientific category in the discipline of physics. This enables education in accordance with the highest academic standards and the strategic goals of the University in the areas of science, research, and innovation. The interdisciplinary nature of the programme allows students to combine knowledge of classical and modern physics with advanced computational methods, materials engineering, electronics, photonics, and experimental data analysis techniques.

The study programme includes both the theoretical foundations of physics and a wide range of practical applications. The use of active teaching methods—such as engineering projects, specialized laboratories, computer simulations, and cooperation with industrial units—supports the development of practical skills and competencies valued in the labour market. Students have the opportunity to participate in research and development projects conducted in cooperation with industry, facilitating the acquisition of experience and a smooth transition to the labour market.

One of the Faculty’s strategic objectives is the development of cooperation with the environment in the areas of consulting, implementation of research projects, and ongoing monitoring of labour market needs. Systematic feedback from external partners makes it possible to maintain the relevance of the curriculum while strengthening its practical and innovative character. These

activities remain fully consistent with the long-term strategy of Lodz University of Technology and its objectives in ensuring the quality of education, advancing science, and fostering effective cooperation with the socio-economic environment.

Educational objectives and employment and continuing education opportunities

Main educational objectives of the Technical Physics programme:

• Development of advanced competencies in physics and mathematics – providing students with a solid foundation in classical and modern physics, higher mathematics, and analytical and numerical methods necessary for modelling physical phenomena and continuing education at the second-cycle (Master’s) level.

• Development of computer modelling skills – preparing students to use modern computational tools, computer simulations, and numerical methods for analysing physical processes, designing technical systems, and solving engineering problems.

• Preparation for work in the photonics sector – developing competencies in optical, laser, and semiconductor physics, the design of selected photonic systems, and optical measurements used in industry.

• Shaping professional and engineering competencies – developing the ability to work individually and in teams, including interdisciplinary teams, strengthening critical thinking, precise formulation of technical communication, and responsibility for the quality of research and engineering projects.

• Preparation for the practical application of physics in modern technology environments – education in integrating physical methods with IT tools, operating advanced measurement equipment, programming environments, and specialized software used in photonics.

· Career paths

The versatility of Technical Physics graduates enables them to find employment in many sectors of the modern economy. They are particularly valued in:

· high-tech industry and energy sector,

· electronics and semiconductor industry,

· design of measurement equipment and new materials,

· IT and data analysis – thanks to strong mathematical and statistical foundations,

· quantum technologies, which are developing rapidly worldwide,

· nuclear energy, requiring a deep understanding of physical processes,

· defence industry,

· finance and consulting, where analytical and complex modelling skills are valued,

· research centres and laboratories,

· nuclear medicine.

Examples of job positions:

Photonics and optoelectronics industry:

· companies producing lasers, detectors, and optical sensors

· companies designing fibre-optic and telecommunication systems

· laboratories working with LED, OLED, and photovoltaic (PV) technologies

· R&D departments of companies producing optical systems and photonic components

Computer modelling and simulations:

· computing centres and HPC (High Performance Computing) facilities

· companies specialising in numerical simulations (FEM/CFD/optical simulations)

· analytical and computational departments in engineering and technology companies

· companies developing modelling and simulation software

Medical physics and healthcare sector:

· medical physics departments in hospitals (radiotherapy, imaging diagnostics)

· CT, MRI, and nuclear medicine laboratories

· companies producing medical equipment (MRI, CT, ultrasound, PET, linear accelerators)

· clinical research centres and biomedical laboratories

Research and development:

· scientific institutes and research laboratories (physics, materials, optics, medicine)

· R&D departments of technology companies

· universities and research units cooperating with industry

· Polish Academy of Sciences (PAN) research centres

· IT and data analytics sector:

· companies involved in data processing and AI (signal and image analysis)

· teams developing algorithms for medical image analysis

· software companies and technology startups (modelling, simulations, AI)

Description of the process and outcome of consultations on the proposed study program with the socio-economic environment

The Institute of Physics at Lodz University of Technology has for many years maintained intensive cooperation with the socio-economic environment, including companies from the modern technology, optoelectronics, photonics, computer modelling, and medical physics sectors, as well as research centres of the Polish Academy of Sciences (PAN). This cooperation is carried out, among others, with companies and institutions such as: VIGO Photonics, TopGun, the National Centre for Radiological Protection in Healthcare in Łódź, and the Department of Experimental Physics at Wrocław University of Science and Technology.

Representatives of the socio-economic environment emphasized the strong theoretical preparation of students and the unique profile of graduates, combining competencies in physics, measurement technologies, data analysis, computer simulations, and optoelectronics

applications—a profile particularly valued in high-tech industries. They also highlighted the high level of practical preparation for work in laboratories and the ability to operate specialized equipment.

From the employers' perspective, the following recommendations were made in particular:

· further development of content related to computer modelling and simulations using widely applied tools (Python, MATLAB),

· expansion of the course block related to optoelectronics, including laser, fibre-optic, and detection technologies,

· strengthening education in the area of medical physics, particularly in imaging methods, quality control, and diagnostic equipment applications,

· introduction of courses familiarizing students with artificial intelligence and experimental data analysis, which are becoming key in modern physics applications.

The indicated directions for programme improvement include:

· increasing the number of student projects covering the full cycle of analysing a physical problem, modelling, data acquisition and processing, model development, interpretation of results, and presentation of conclusions,

· introducing a greater number of real-life engineering and research problems with the participation of industry partners, including their involvement in selected classes,

· maintaining a balance between content related to optics and optoelectronics, computer modelling, and nuclear physics, so that the programme meets the needs of students with diverse technological interests.

In summary, representatives of the socio-economic environment assessed the study programme as modern and well aligned with the needs of the high-tech industry and institutions related to applied physics—the programme received a positive evaluation.

Description of competencies expected from a candidate applying for admission to studies

In accordance with the current Admission Resolution at Lodz University of Technology.

The unit organizing education

Faculty of Technical Physics, Information Technology and Applied Mathematics

Education program

Semester 1

Course	Number of hours	ECTS points	Form of verification	Obligatory
Fundamentals of Physics	Tutorials: 75 Lecture: 75	9	Exam	Obligatory
Elements of Mathematical Analysis I	Tutorials: 60 Lecture: 30	6	Exam	Obligatory
Algebra with Analytic Geometry I	Tutorials: 45 Lecture: 30	5	Graded assignment	Obligatory
Experimental Data Analysis I	Tutorials: 15 Laboratory classes: 15 Lecture: 15	3	Graded assignment	Obligatory
Intellectual Property Protection	Lecture: 15	2	Graded assignment	Obligatory
Teamwork	Project work: 30	2	Graded assignment	Obligatory subjects to choose from
Information Technologies I	Laboratory classes: 30 E-learning: 15	3	Graded assignment	Obligatory
Sum	**450**	**30**		

Semester 2

Course	Number of hours	ECTS points	Form of verification	Obligatory
Vibrations and Waves	Tutorials: 30 Lecture: 30	5	Exam	Obligatory
Electricity and Magnetism	Tutorials: 30 Lecture: 30	5	Exam	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Elements of Mathematical Analysis II	Tutorials: 45 Lecture: 30	6	Graded assignment	Obligatory
Algebra with Analytic Geometry II	Tutorials: 45 Lecture: 15	5	Exam	Obligatory
Information Technologies II	Laboratory classes: 30 E-learning: 15	3	Graded assignment	Obligatory
Experimental Data Analysis II	Tutorials: 15 Laboratory classes: 15 Lecture: 15	3	Graded assignment	Obligatory
Scientific Seminar I	Seminar: 10	1	Graded assignment	Obligatory
Foreign Language Module 1		2	Graded assignment	Obligatory group
The student chooses one module from the group.				
English B2 module I	Tutorials: 30	2	Graded assignment	Optional
English B2+ module I	Tutorials: 30	2	Graded assignment	Optional
English C1 module I	Tutorials: 30	2	Graded assignment	Optional
German B2 module I	Tutorials: 30	2	Graded assignment	Optional
Physical Education 1	Tutorials: 30	0	Pass	Obligatory
Sum	**415**	**30**		

Semester 3

Course	Number of hours	ECTS points	Form of verification	Obligatory
Experimental Physics I	Laboratory classes: 45	3	Graded assignment	Obligatory
Introduction to Modern Physics	Tutorials: 30 Lecture: 30	5	Exam	Obligatory
Theoretical Mechanics	Tutorials: 30 Lecture: 30	5	Exam	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Open Source Software	Laboratory classes: 45	3	Graded assignment	Obligatory
Basics of Programming	Laboratory classes: 30 Lecture: 30	4	Graded assignment	Obligatory
Differential Equations in Physics I	Tutorials: 20 Laboratory classes: 20 Lecture: 20	5	Graded assignment	Obligatory
Elective Courses 1		3	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Geometrical and Physiological Optics	Tutorials: 15 Laboratory classes: 15 Lecture: 15	3	Graded assignment	Optional
Photography	Project work: 30 Lecture: 15	3	Graded assignment	Optional
Foreign Language Module 2		2	Graded assignment	Obligatory group
The student chooses one module from the group.				
English B2 module II	Tutorials: 30	2	Graded assignment	Optional
English B2+ module II	Tutorials: 30	2	Graded assignment	Optional
English C1 module II	Tutorials: 30	2	Graded assignment	Optional
German B2 module II	Tutorials: 30	2	Graded assignment	Optional
Physical Education 2	Tutorials: 30	0	Pass	Obligatory
Sum	**435**	**30**		

Semester 4

Course	Number of hours	ECTS points	Form of verification	Obligatory
Experimental Physics II	Laboratory classes: 45	4	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Engineering Documentation and Graphics	Laboratory classes: 30	2	Graded assignment	Obligatory
Numerical Methods of Computational Physics I	Laboratory classes: 60 Project work: 15 Lecture: 30	8	Graded assignment	Obligatory
Scientific Seminar II	Seminar: 15	3	Graded assignment	Obligatory
Nuclear Technique	Tutorials: 15 Laboratory classes: 30 Lecture: 15	3	Graded assignment	Obligatory
Elective Courses 2		4	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Liquid Crystals	Tutorials: 10 Laboratory classes: 15 Lecture: 20	4	Graded assignment	Optional
Scientific Results Presentation	Laboratory classes: 30 Lecture: 15	4	Graded assignment	Optional
Elective Courses 3		4	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Introduction to Quantum Mechanics	Tutorials: 30 Lecture: 30	4	Graded assignment	Optional
Mathematical Foundations of Quantum Systems	Tutorials: 30 Lecture: 30	4	Graded assignment	Optional
Foreign Language Module 3		2	Graded assignment	Obligatory group
The student chooses one module from the group.				
English B2 module III	Tutorials: 30	2	Graded assignment	Optional
English B2+ module III	Tutorials: 30	2	Graded assignment	Optional
English C1 module III	Tutorials: 30	2	Graded assignment	Optional
German B2 module III	Tutorials: 30	2	Graded assignment	Optional
Sum	**390**	**30**		

Semester 5

Course	Number of hours	ECTS points	Form of verification	Obligatory
Electrodynamics	Tutorials: 30 Lecture: 30	4	Exam	Obligatory
Solid State Physics	Tutorials: 30 Lecture: 30	4	Graded assignment	Obligatory
Electronics and Electrical Engineering in Physical Research	Tutorials: 20 Lecture: 30	4	Graded assignment	Obligatory
Numerical Methods of Computational Physics II	Project work: 30 Lecture: 15	4	Graded assignment	Obligatory
Selected Topics in Chemistry	Tutorials: 15 Lecture: 15	2	Exam	Obligatory
Elective Courses 4		5	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Microscopic Thermodynamics and Statistical Mechanics	Tutorials: 30 Lecture: 30	5	Graded assignment	Optional
Microscopic Thermodynamics and Statistical Mechanics	Tutorials: 30 Lecture: 30	5	Graded assignment	Optional
Elective Course 5		4	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Mathematical Methods in Physics	Tutorials: 30 Lecture: 30	4	Graded assignment	Optional
Experimental Physics III	Project work: 60	4	Graded assignment	Optional
Foreign Language Module 4		3	Exam	Obligatory group
The student chooses one module from the group.				
English B2 module IV	Tutorials: 30	3	Exam	Optional
English B2+ module IV	Tutorials: 30	3	Exam	Optional

Course	Number of hours	ECTS points	Form of verification	Obligatory
English C1 module IV	Tutorials: 30	3	Exam	Optional
German B2 module IV	Tutorials: 30	3	Exam	Optional
Physical Education 3	Tutorials: 30	0	Pass	Obligatory
Sum	**425**	**30**		

Semester 6

Course	Number of hours	ECTS points	Form of verification	Obligatory
Electronics Laboratory	Seminar: 15 Laboratory classes: 45	4	Graded assignment	Obligatory
Differential Equations in Physics II	Tutorials: 30 Lecture: 30	4	Graded assignment	Obligatory
Lasers and Their Selected Applications in Physics	Laboratory classes: 25 Lecture: 20	2	Graded assignment	Obligatory
Optoelectronics	Project work: 30 Lecture: 30	4	Graded assignment	Obligatory
Solid Crystals	Laboratory classes: 15 Lecture: 20	2	Graded assignment	Obligatory
Engineering Project I	Project work: 120	10	Graded assignment	Obligatory subjects to choose from
Elective Courses 6		4	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Digital Technology	Laboratory classes: 30 Lecture: 30	4	Graded assignment	Optional
Optical Microscopy	Laboratory classes: 45 Lecture: 15	4	Graded assignment	Optional
Sum	**440**	**30**		

Semester 7

Course	Number of hours	ECTS points	Form of verification	Obligatory
History of Physics	Lecture: 15	2	Graded assignment	Obligatory
Final Project	Diploma Thesis: 0	15	Pass	Obligatory subjects to choose from
Internship	Internship: 0	6	Pass	Obligatory
Diploma Seminar	Seminar: 15	2	Graded assignment + exam	Obligatory
Engineering Project II	Project work: 60	3	Graded assignment	Obligatory subjects to choose from
Elective Courses 7		2	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Selected Topics in Molecular Physics	Laboratory classes: 15 Project work: 15 Lecture: 15	2	Graded assignment	Optional
Methods for Describing Electronic	Laboratory classes: 15 Lecture: 30	2	Graded assignment	Optional
Sum	**135**	**30**		