Lodz University of Technology

Study programme

Faculty:	Faculty of Chemistry
Major:	Nanotechnology
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:	Nanotechnology
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:	2700
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:	108
Professional title awarded to graduates:	inżynier
ISCED code:	0531
Language of study:	polish

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

Discipline	Percentage share
Chemical science	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	**1NAN1**	Has advanced knowledge of chemistry, mathematics and physics that is essential for formulating and solving technical problems, taking into account the latest developmental trends in the field of nanotechnology.	P6U_W	P6S_WG
2	**1NAN2**	Has advanced and theoretically structured knowledge in the field of nanoscience and nanotechnology, knows the connections with physics, chemistry, materials engineering, biology, as well as its applications in the economy.	P6U_W	P6S_WG
3	**1NAN3**	Has advanced and theoretically structured knowledge of research methods, techniques and tools, including computer-aided ones, used in chemistry, physics, nanoscience and nanotechnology, taking into account the principles of occupational health and safety, ergonomics, standardization and the life cycle analysis of devices, systems and technical objects.	P6U_W	P6S_WG
4	**1NAN4**	Knows and understands the social, economic, legal and other non-technical conditions of engineering activities.	P6U_W	P6S_WK
5	**1NAN5**	Is able to search for information in the field of nanotechnology, chemistry and chemical technology from available sources (databases, professional literature, etc.) in Polish and foreign languages, has language skills in line with the requirements specified for level B2 of the Common European Framework of Reference for Languages.	P6U_U	P6S_UW, P6S_UK
6	**1NAN6**	Is able to design materials, technical devices and technological processes used in nanotechnology using appropriate methods and tools, also recognizing non-technical aspects and critically assessing the current state of technology in the field of nanotechnology.	P6U_U	P6S_UW
7	**1NAN7**	Is able to work in a team, playing different roles, and is able to plan and implement his/her own learning, even after completing his/her studies.	P6U_U	P6S_UO, P6S_UU
8	**1NAN8**	Is able to plan, perform experiments, calculations, simulations, critically analyze the obtained results, formulate conclusions and recommendations.	P6U_U	P6S_UW
9	**1NAN9**	Is aware of the importance of the engineering profession and the accompanying dilemmas: scientific, technical and non-technical: ethical, legal, economic and social related to the profession.	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	**1NAN10**	Is prepared to fulfill social responsibilities, inspire and organize activities for the benefit of the community, initiate projects in the public interest, and think and act in an entrepreneurial manner while adhering to the principles of ethics, sustainable development, and professional responsibility in the field of nanotechnology and related areas.	P6U_K	P6S_KO

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

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
1	Mathematics I	Number sequences, their properties, and limits. Differential calculus of functions of one variable. Limits of functions. The derivative and its geometric and physical interpretation. Integral calculus of functions of one variable.	x							x		
2	General and Inorganic Chemistry I	Fundamental concepts, laws, and models describing the structure of matter, the atom, and nuclear phenomena. Structure and properties of chemical compounds, types of bonds, the periodic table of elements, and equilibria in solutions. Reaction mechanisms, stoichiometric calculations, and the application of physicochemical processes in material design.	x							x		
3	Nanotechnology and Nanoscience	History and fundamentals of nanotechnology and the properties, classifications, and fabrication methods of nanomaterials of various dimensionalities. Applications of nanostructures in medicine, biology, electronics, environmental protection, and the development of nanomedicine and computational modeling. Synthesis and use of polymer nanocomposites, metallic and hybrid nanomaterials, and their roles in catalysis and chemical analysis.		x								
4	Information Technology	Fundamentals of computer operation, networking, security, and work in Microsoft 365 along with the use of specialized software for calculations and data visualization. Introduction to algorithmics and Python programming with implementation and diagnostics of engineering algorithms. Development of skills for performing engineering computations in various computational environments.			x					x		
5	Introduction To Data Analysis	Measurement errors and statistical data description along with fundamentals of distributions, estimation, and hypothesis testing. Linear and nonlinear regression and fitting methods with assessment of model quality. Practical data processing using spreadsheets and specialized analysis software.	x							x		
6	The Art of Studying	Structure and functioning of higher education and the organization of chemical studies at the university. Regulations on study progress, mobility, and thesis work along with methods supporting learning and presentation. Development of skills in self-presentation, cognitive techniques, and preparation for specialization.				x						
7	Ecology and Environmental Ethics	Fundamentals of ecology and evolution covering levels of biological organization, adaptations, and the functioning of populations and ecosystems. Biogeochemical cycles, global biomes, and applied ecology in environmental protection and resource management. Major environmental threats, key eco-philosophical approaches, and international conservation strategies including sustainable development and the Natura 2000 system.				x						
8	History of Chemistry and Chemical Industry	Development of chemistry from alchemy to a modern science and the rise of the chemical industry and key atomic theories. Formation of major branches of chemistry, including organic, coordination, solution, and nuclear chemistry. Links between chemistry, environmental protection, and the impact of wars on scientific progress.				x						
9	Mathematics II	Differential calculus of functions of several variables. Integral calculus of functions of two variables. Ordinary differential equations. Linear differential equations of second order. Numerical and functional series.	x							x		

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
10	General and Inorganic Chemistry II	Classification and nomenclature of inorganic compounds, their structure, properties, preparation methods, and oxidation-reduction reactions. Properties and applications of main group elements and transition metals, allotropes, industrial processes, and materials used in various industries. Ionic equilibrium, pH calculations, redox reactions and equation balancing, and stoichiometric calculations for mixtures and excess reagents.	x							x		
11	Physics	Fundamentals of mechanics, electromagnetism, and optics including laws of motion, energy, gravitational, electrostatic, and magnetic fields, as well as mechanical and electromagnetic waves. Conservation laws, oscillations, waves, Maxwell’s equations, and optical phenomena illustrated with demonstrations. Practical measurement techniques in mechanics, optics, electricity, and magnetism applied in computational and laboratory exercises.	x							x		
12	Artificial Intelligence and Cybersecurity	Topics related to AI and its applications, artificial intelligence methods used in threat analysis and security process automation. Vulnerability identification, attack models, and data protection principles in IT systems. Design and evaluation of systems using AI algorithms for anomaly detection, network monitoring, and security incident response.			x					x		
13	Mechanics and Strength of Materials	Fundamentals of statics and strength of materials including equilibrium of force systems, stresses, strains, and fatigue phenomena with structural calculation methods. Analysis of bending, shear, torsion, and buckling along with the application of strength hypotheses. Practical testing of material properties such as tensile strength, hardness, impact resistance, creep, and stress relaxation.	x	x						x		
14	English B2 module I	Part I of the business language course with elements of industry-specific language; development of all language skills; development and improvement of soft skills focused on the graduate's future work environment.					x					
15	English B2+ module I	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 C1 module I	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	German B2 module I	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	Organic Chemistry	Electronic structure of atoms, hybridization, and bonding types determining the structure and stereochemistry of organic compounds. Properties, nomenclature, reactions, and mechanisms for major functional groups including alkanes, alkenes, halides, alcohols, aldehydes, ketones, acids, acid derivatives, and amines. Application of structural rules and reactivity principles to problem-solving and planning organic syntheses.	x							x		

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
19	Analytical Chemistry	Fundamentals of analytical chemistry: role, parameters characterizing methods, analytical errors, and statistical interpretation of results. Analytical techniques: acid-base titration, redox reactions, complexometry, and precipitation reactions with mechanisms and influencing factors. Criteria for method selection, scientific information sources, application of complex compounds in chemical analysis, and citation principles.	x							x		
20	Engineering Design and Graphics	Elements of technical drawing including projection methods, dimensioning, sections, and preparation of detail and assembly drawings. Standards used in chemical process flow diagrams. Fundamentals of CAD-based computer-aided design for producing technical documentation.			x							
21	Ceramic and Metal Nanomaterials	Types of ceramic raw materials and materials, including nano-raw materials, their properties, micro- and nanostructure, and analytical methods. Ceramic nanomaterials and nanocomposites together with sol-gel processes and fabrication technologies. Production, properties, and applications of glass and specialized ceramics, including refractory and ballistic materials.		x						x		
22	Polymers and Functional Materials	Fundamentals of polymer chemistry and science including preparation methods, structure, molecular weight, phase transitions, cross-linking, degradation, and classification. Mechanical, rheological, thermal, acoustic, electrical, and optical properties and the development of functional and smart polymers. Processing, recycling, and practical laboratory techniques including synthesis, identification, and preparation of elastomer mixtures.	x	x						x		
23	Electrical Engineering with Elements of Electronics	Fundamentals of electrical engineering and electronics including electrical quantities, circuit components, and methods of analyzing DC and AC circuits. Operating principles of selected electrotechnical and electronic devices and their practical applications in technology and everyday life. Hands-on training in circuit assembly, electrical measurements, and laboratory instrumentation.	x							x		
24	English B2 module II	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					
25	English B2+ module II	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					
26	English C1 module II	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					
27	German B2 module II	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	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
28	Technology of Polymer Synthesis and Processing	Rheological and mechanical properties of polymers, including phase transitions, deformations, viscoelasticity, and processing conditions for shaping and reinforcing polymer materials. Technological polymerization methods and fabrication of major polymer groups along with their properties and applications. Practical studies of relaxation, creep, viscosity, extrusion, synthesis, and thermal analysis of polymers.		x						x		
29	Quality Management and Normalization	Principles, goals and structure of standardization, types of standards and stages of their development, along with practical methods for finding and using normative documents. Evolution of quality concepts and management systems, quality tools and the TQM philosophy. ISO 9001, ISO 14001 and ISO 17025 standards, implementation and certification processes, and the benefits of quality systems within organizations.				x	x	x				
30	Physical Chemistry	Thermodynamics and chemical kinetics covering the description of matter structure and states, state functions, phase and chemical equilibria, electrolyte conductivity, and the fundamentals of electrochemistry and surface processes. The laws of thermodynamics, properties of ideal and real solutions, transport phenomena, and basic molecular spectroscopy applied to the analysis of transformations. Practical calculations and calorimetric, conductivity, electromotive-force, and reaction-kinetics measurements in systems of varying complexity.	x							x		
31	Instrumental Analysis	Molecular and atomic spectroscopy including absorption, emission, electrochemical and chromatographic methods together with theoretical foundations, instrumentation and analytical applications. Advanced NMR, Raman spectroscopy and mass spectrometry techniques used for spectral interpretation, structural analysis, compound identification and environmental sample examination. Practical qualitative and quantitative determinations of metals, anions and organic compounds using UV-VIS, IR, NMR, MS, ICP-AES, AAS, voltammetry and HPLC.	x							x		
32	Polymer Nanomaterials	Parameters characterizing polymers. Methods of preparation. Polymer structure. Polymer architecture. Block polymers. Star polymers. Molecular brushes. Hybrid materials. Polymer networks. Dendrimers. L: Synthesis and properties of various types of polymer nanomaterials.		x						x		
33	Design of Products from Polymer Materials	Principles of polymer material design including load response, strength indicators, and selection criteria based on fatigue, wear, and environmental resistance. Comparison of polymers and composites with other engineering materials, their limitations, and typical applications supported by modeling tools and multiscale analyses. Selection of materials, additives, processing methods and process scale using functional charts, material databases and design tools together with cost analysis.		x				x				
34	English B2 module III	Part III of the business language course with elements of industry-specific language; development of all language skills; development and improvement of soft skills focused on the graduate's future work environment.					x					
35	English B2+ module III	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					

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
36	English C1 module III	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					
37	German B2 module III	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					
38	Solid State Physics	Fundamentals of solid-state physics including crystalline and amorphous structure, bonding types, lattice dynamics, thermal properties, conductivity and band theory of metals and semiconductors. Principles of lasers, radiation and photoelectric effects together with intrinsic and doped conductivity and p-n junction behavior. Properties of macromolecules and polymers determining structure, conformation, crystallinity, glass transition and melting, along with methods for examining their physical states and morphology.	x	x						x		
39	Process Engineering and Environmental Technologies	Unit operations including fluid flow, particle settling, mixing, and heat and mass transfer such as conduction, convection, radiation, distillation, rectification and drying. Laboratory studies of drying kinetics, flow resistance, heat and mass transfer and model sedimentation and rectification processes. Environmental protection technologies based on sustainable development, green chemistry, clean processes, emission and waste reduction and life-cycle analysis together with best available techniques (BAT).	x							x		
40	Materials Recycling	Classification and cataloguing of waste and the principles of waste management together with EU and national legal regulations and required documentation. Sources and use of primary and secondary raw materials, including recovery, end-of-waste status and utilization of mineral waste materials. Methods for treating hazardous waste and the scope and techniques of waste analysis.			x			x				
41	English B2 module IV	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					
42	English B2+ module IV	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					
43	English C1 module IV	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					
44	German B2 module IV	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	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
45	English Technical Terminology and Chemical Scientific Information Sources	Scientific terminology and definitions including laws, symbols, abbreviations, chemical nomenclature and vocabulary related to chemical and physical laboratories. Terminology of chemical, physicochemical, physical, technological and nanotechnology-related processes together with translation of selected technical texts. Practical introduction to using major scientific databases and building personal databases and reference lists with tools such as EndNote Web.					x					
46	English Scientific Terminology and Sources of Chemical Scientific Information	Practical introduction to using English-language scientific databases, journal platforms and tools for building personal reference lists and literature repositories. Learning chemical and technical terminology related to matter structure, materials and processing with emphasis on nanomaterials and nano-additives. Developing skills in writing and translating scientific texts in English, including abstracts, research reports and results sections.					x					
47	Polymeric and Engineering Nanomaterials	Nanomaterials and nano-fillers used in the polymer industry and their influence on the properties, structure and performance of polymer nanocomposites and biocomposites, with emphasis on structural nanocomposites. Methods of obtaining nanocomposites, including those from polymer recyclates and rubber/polymer waste, and processes of ageing, degradation and stabilization of polymer materials. Techniques for examining the structure and properties of nanomaterials and nanocomposites together with analysis of dynamic and surface features of selected systems.	x	x						x		
48	Radiation Chemistry and Technology of Polymers	Fundamentals of ionizing-radiation interactions with matter including gamma-ray and electron-beam dosimetry and their use in determining doses and fluxes in laboratory systems. Radiation-induced crosslinking of polymers used to modify material performance and controlled radiolytic degradation of polymeric materials. Demonstration-based laboratory exercises enabling observation of irradiation effects and analysis of physicochemical changes in polymer structures.										
49	Polymeric and Engineering Nanomaterials	Classification of macromolecules, conformation and configuration, tacticity, cis–trans isomerism, and molecular weights with their distributions. Intermolecular interactions: electrostatic, dipolar, dispersion, hydrophobic forces and hydrogen bonding. Macromolecular dimensions, flexible-chain statistics, persistent chain, segment length, excluded volume and basic chain models. Polymer solutions in dilute, semidilute and concentrated regimes, expansion coefficient, blobs and de Gennes scaling. Polymer mixing: enthalpy and entropy, lattice model, Flory–Huggins equation, solubility parameter and phase diagrams. Polymer fractionation, solution viscosity, intrinsic viscosity, Mark–Houwink relation, hydrodynamic basics, equivalent-sphere model and Flory equation. Polymer diffusion and diffusion-coefficient measurements. Light scattering: Zimm method, Rayleigh–Debye scattering, static and dynamic techniques. Polyelectrolyte solutions, electrokinetic phenomena, Donnan equilibrium, Manning counterion condensation, associative colloids and micellization. Molecular and thermodynamic description of surfaces, surface tension and energy, wetting and contact angle, crystallographic structure and surface defects. Physical and chemical adsorption, thermodynamic adsorption description, Langmuir isotherm, BET multilayer adsorption, heat of adsorption and capillary condensation. Surface–particle interactions and electrical double layer. Analytical methods: LEED, UV PES, ESCA/XPS, Auger spectroscopy, RBS, TPD, IR spectroscopy, HREELS, ToF-SIMS and scanning microscopy.	x	x				x	x	x		

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
50	Polymer Radiation Chemistry and Technology	The physical and chemical consequences of light absorption are presented in the context of molecular orbital structure, electronic configuration, and accessible electronic states, including both radiative and non-radiative transitions. The description includes mechanisms of excited-state quenching, principles of photochemical reaction kinetics, and typical instrumentation used in photochemistry. Photochemical processes such as photoisomerization, molecular rearrangements, and photoenolization are discussed, together with the fundamentals of photocatalysis, photobiology, and solid-state physics, with particular emphasis on electronic states in crystals and band structure. Elements of statistical physics, the external photoelectric effect, the Compton effect, and the optical properties of solids—along with the interpretation of absorption bands—are covered, as well as charge-carrier photogeneration, photoconductivity, and the photovoltaic effect. The content also includes the basics of nonlinear optics, photochromism, and holography. Laboratory work encompasses actinometry, photoisomerization and photoreduction reactions, studies of electroluminescence in p–n junctions, spectral analysis of light-emitting diodes, and experiments related to photoconductivity and photogeneration.	x	x				x	x	x		
51	Polymeric and Engineering Nanomaterials	An introduction to fundamental material processing methods and technologies, together with the operating principles of equipment used in production engineering. Discussion of key machine components, their functions and selection criteria in relation to technological processes. Development of an understanding of the relationships between material properties, equipment parameters and the efficiency of processing operations.	x	x				x	x	x		
52	Polymer Radiation Chemistry and Technology	An introduction to processes used to tailor the properties of material surface layers and to methods of their modification using physical and chemical techniques. Discussion of factors affecting surface structure, adhesion, stability and functional performance in technical applications. Development of the ability to select basic surface engineering methods according to material type and required operational characteristics.	x	x				x	x	x		
53	Simulation and Computational Techniques in Chemistry and Nanotechnology	Computer experiments in chemistry involving model construction and system representation, selection of numerical methods and evaluation of accuracy and error propagation in simulations. Molecular simulations based on force fields, molecular dynamics, Monte Carlo methods and stochastic or kinetic approaches together with analysis and visualization of computed properties. Practical use of simulation software and development of a project solving a selected computational problem.			x			x				
54	Summative Module	Interdisciplinary project work requiring application of knowledge and skills gained during nanotechnology studies together with competencies in project management, standardization and life-cycle analysis. Team-based problem solving enabling integration of material, technological and environmental aspects to address a complex engineering task. The project serving as a means to verify achievement of learning outcomes specified in the study program.										
55	Smart Polymers	Smart polymer materials including piezoelectric, photoactive, magnetic systems and polymers with shape-memory behavior and electrical conductivity, together with principles of their functional response. Manufacturing technologies for such materials and their use as sensors and components reacting to thermal, optical or mechanical stimuli. Laboratory investigation of shape-memory thermoelastoplasts, thermochromic polymers and photochromic polymers.		x						x		

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
56	Nanoparticles and the Environment	Environmental-protection legal issues related to the risks posed by releasing nanoscale particles into natural ecosystems and the assessment of their ecotoxicity and biological impact. Nanotechnologies used in environmental monitoring, diagnostics and remediation and their importance for sustainable development for future generations. Student preparation of selected literature-based topics expanding on the lecture material.		x						x		
57	Ultrasound in Nanotechnology	Ultrasound as a chemical and physicochemical tool involving wave generation, interactions with matter and cavitation mechanisms leading to sonochemical reactions. Applications of ultrasound in the synthesis and modification of polymers, nano-gels and nanomaterials as well as in material characterization, defectoscopy and ultrasonic microscopy. Practical exercises including operation of an ultrasonic reactor, sonochemical polymerization and synthesis of nanoparticles and nano-gels, with emphasis on safety rules for working with ultrasonic devices.										
58	Conductive Polymeric Nanomaterials	Electrical conductivity in polymer materials including band theory, distinctions between conductors, semiconductors and insulators, and the development and applications of conductive polymers. Charge-transport mechanisms, percolation theory and the role of composites and nanocomposites with organic or inorganic conductive phases, together with fabrication methods and electronic applications. Practical investigations of thin-film conductivity, percolation behavior and determination of percolation thresholds in polymer composites with varying filler content.		x						x		
59	Nanofillers and Nanocomposites	Basic concepts of nanotechnology, nanofillers, and nanocomposites. Types of nanofillers. Structure and properties of nanofillers. Types of nanocomposites. Types of polymers used in nanocomposites. Methods of production. Properties of nanocomposites. Applications of nanocomposites. L: Synthesis and testing of the basic properties of nanofillers.		x						x		
60	Polymer Materials in Construction	Basic properties of polymer materials and their importance in construction applications. The most important thermoplastics and thermosetting and thermosetting plastics, their production, processing, and use in building structures: polyethylene, polypropylene, polyisobutylene, polystyrene, poly(vinyl chloride), homopolymers of conjugated dienes, poly(methyl methacrylate), poly(vinyl acetate), polyesters, polycarbonates, polyamides, polyurethanes; unsaturated polyester resins, epoxy resins, phenol-formaldehyde resins, aminoplasts; organosilicon polymers. Main areas of application of plastics in building structures: wall and floor materials, roofing materials; sealing and thermal insulation materials; films and membranes; adhesives, paints and coatings - finishing building surfaces and protecting them against water and aggressive factors; laminates and composites; polymer concretes; pipes and fittings for sanitary installations.		x						x		
61	Hybrid Nanocomposites	Electronic properties of atoms, solids, and nanoparticles, as well as methods for producing inorganic nanometric materials and techniques for their characterization, with particular emphasis on surface functionalization. Hybrid organic-inorganic nanocomposites, including classification, principles of synthesis, and analysis of their electrical and magnetic properties, along with potential applications. Practical exercises on the preparation of oxide layers and "brushes," thermo-optical studies, and the synthesis of nanocomposites for glass surface modification.		x						x		
62	Supramolecular Chemistry	Fundamentals of supramolecular chemistry, including the concepts of weak interactions, self-assembly and molecular recognition, and the role of receptors in binding cations, anions, and neutral molecules. The template effect, supramolecular reactivity and catalysis, and the development of molecular devices and future directions in this field. A practical introduction to the synthesis and study of host-guest complexes with potential biological properties.		x						x		

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
63	Fundamentals of Crystallography	Fundamentals of crystallography including the definition of crystals, lattice structures, symmetry elements, crystallographic systems, Bravais cells and space groups, as well as crystallization processes and crystal-growth methods. X-ray diffraction, Laue and Bragg equations, the Ewald construction and factors influencing reflection intensity used for phase analysis, crystallite-size determination, crystallinity assessment and unit-cell parameter evaluation. Modern characterization techniques for materials including thin-film and polymer diffraction, complemented by laboratory work on symmetry, phase analysis and diffraction-pattern indexing.		x						x		
64	Basics of Biochemistry	Chemical composition of organisms including the structure and functions of amino acids, proteins, enzymes and nucleic acids, along with mechanisms of DNA replication and protein biosynthesis. Fundamentals of metabolism involving carbohydrates, lipids, their energy transformations and the organization of metabolic pathways. Practical laboratory techniques covering protein determination, isolation of plant pigments and DNA extraction.		x						x		
65	Polymers in Medicine	Biomaterials science covering the history, classification, properties and biocompatibility of medical materials and the characteristics of metals, ceramics, polymeric glasses and polymers including hydrogels, copolymers and biodegradable systems. Surface properties of biomaterials, analytical techniques, surface-modification methods and applications in tissue engineering and controlled drug-delivery systems alongside sterilization principles and radiation-based biomaterials engineering. Practical fabrication of biodegradable matrices, hydrogel dressings and polymer coatings as well as encapsulation of bioactive compounds, supported by an industry visit to a biomaterials manufacturer.		x						x		
66	Thin-Film Technology	Thin-film fabrication methods including physical and chemical vapor-phase techniques and liquid-phase deposition such as vacuum evaporation, ion and cathodic sputtering, CVD and solution-based methods: spin-coating, dip-coating, drop-casting, Langmuir-Blodgett and ink-jet printing. Criteria for selecting the deposition method based on material type, required thickness, surface quality and application, along with techniques for thin-film thickness measurement. Practical preparation and characterization of polymer, metallic and dielectric layers involving coating processes, spectrophotometric analysis, thickness determination, surface roughness and optical-property evaluation.		x						x		
67	Polymers in Transport and Automotive Applications	Polymer structural materials used in automotive, aviation and railway applications together with their properties, identification methods and principles for designing mechanically loaded components. Material-selection criteria including wettability, adhesion, friction, wear resistance, thermal stability and chemical durability supported by spectroscopic and performance testing. Practical examination of structural polymers covering friction behaviour, fatigue, swelling kinetics and thermal stability.	x	x						x		
68	Nanoparticles, Dispersions, and Polymeric Gels	Polymer systems with high dispersion including nano- and microparticles, gels, emulsions, colloids and polymer aggregates together with preparation methods such as emulsion, solution and bulk polymerization, and classical, photochemical, radiation and sonochemical crosslinking. Characterization of homogeneous and heterogeneous structures, core-shell particles, microcapsules and stimulus-responsive systems along with their properties and interactions with synthetic materials and biological environments. Applications of nano- and microparticles and polymer gels in optics, medicine, biotechnology, cosmetics and materials engineering, complemented by laboratory work on synthesis, complexation, swelling kinetics and the study of smart hydrogels.										

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
69	Operation and Elements of Tribology	Theories of friction and wear covering friction laws, classification of tribological wear mechanisms and characteristics of machine friction nodes along with methods of diagnostics and lubrication. Principles of selecting and operating lubricants based on the Stribeck curve, durability, reliability and lifetime prediction of machine components. Studies of the influence of load, speed, geometry, lubrication and degradation on tribological behaviour supported by microscopic and spectroscopic analysis of surfaces and wear products.	x	x						x		
70	Conjugated Polymers	Conjugated polymers involving the structure and properties of π-electron chains, polymerization mechanisms, modification strategies and charge-transport principles based on solitons, polarons and bipolarons. Doping, photophysics and photoelectrochemistry governing conductivity and stability along with an overview of major representatives such as polyacetylene, polypyrrole, polyaniline and polythiophenes. Applications in organic electronics, sensing, photovoltaics and electroluminescent devices supported by a project focused on selecting a conjugated polymer for a specific application.	x	x						x		
71	Cosmetic Materials and Nanomaterials	Structure, physiology and biochemistry of the skin determining the penetration of drugs and cosmetics and the roles of inorganic ingredients, lipids, silicones, polyols and liposomes in cosmetic formulations. Technologies for producing emulsions, stabilizing systems and using antioxidants, preservatives, UV filters and components of deodorants, antiperspirants and oral-care and hair-care products including dyes and styling agents. Practical preparation of protective creams, hair-care formulations and lip-care products with evaluation of their performance.	x	x						x		
72	Fundamentals of Adsorption and Catalysis	Phenomena of physical adsorption and chemisorption at solid–gas and solid–liquid interfaces together with theoretical models such as Henry’s equation, Langmuir isotherm and BET theory, and methods for determining surface area and classifying industrial adsorbents. Fundamentals of heterogeneous catalysis covering the importance of catalysis, activity and selectivity, the role of supports and theories describing active sites and catalytic mechanisms. Practical evaluation of catalyst activity and surface properties using BET, TOF-SIMS and SEM-EDS techniques and analysis of catalyst morphology and physicochemical characteristics.										
73	Elements of Biology and Medicine	Chemical foundations of life including the role of micro- and macroelements, water–electrolyte balance and the functioning of the animal cell as the structural unit of living organisms. Structure and physiology of human body systems, mechanisms of innate and adaptive immunity and the body’s responses to artificial structures relevant to nanotechnology and biomaterials. Practical training in biological laboratory methods involving cell cultures, cell counting and assays assessing cytotoxicity and viability after material exposure.	x	x						x		
74	Chemistry – Engineering of the Future	Recent Advances in Chemistry – molecular machines, designing systems with diverse properties from a single atom type. Hierarchy and Nanomaterials – using hierarchical structures to create particles with defined features, applications of nanomaterials. Modern Challenges in Chemistry – role in sustainable development and Industry 5.0 technologies.	x	x						x		
75	Methods of Investigating Engineering Nanomaterials	Engineering materials and their nanostructured variants covering classification, structure and properties of polymer nanomaterials along with characterization techniques such as microscopy, X-ray methods, spectroscopy and particle-size analysis. Influence of nanomaterials on the mechanical, thermal and barrier performance of composites and methods for studying structural and property changes during ageing. Practical use of TGA, DSC, spectroscopic analysis, DLS, granulometry and mechanical testing for examining nanocomposites, nanofibers and nano-fillers.			x					x		

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
76	Methods for the Investigation of Functional Nanomaterials	Introduction to the operating principles of selected analytical techniques and their applications in nanotechnology with focus on UV-VIS, Raman, IR, 1H HR MAS and dielectric spectroscopy. Laboratory practice involving sample preparation, calibration and evaluation of capabilities and limitations of methods used for studying nanolayers, crystal structures, optical properties and chemisorption processes. Analysis of nanomaterial-related problems using XRD, DLS/SLS, SEM and electrical-property measurements of thin films.			x					x		
77	Pre-Diploma Project A - Nanomaterials in Catalysis and Environmental Protection	The project involves independent development of an issue related to the use of nanomaterials in catalytic processes and in solutions aimed at environmental protection, including analysis of theoretical foundations, selection of research or analytical methods, performance of necessary tests, and development, interpretation and presentation of results in the context of the adopted design assumptions.		x	x		x	x	x	x		
78	Pre-Diploma Project B - Physicochemical and Medical Aspects of Nanotechnology	The project involves independent development of an issue concerning the physicochemical and medical aspects of nanotechnology, including analysis of the theoretical foundations, selection of appropriate research or analytical methods, performance of necessary tests, and development, interpretation and presentation of results in relation to the design assumptions and the nature of the selected problem.										
79	Pre-Diploma Project C - Synthesis and Technology of Polymeric and Composite Materials	The project involves independent development of an issue related to the synthesis and technology of polymer and composite materials, including analysis of theoretical foundations, selection of appropriate research or analytical methods, performance of necessary tests, and development, interpretation and presentation of the obtained results in relation to the design assumptions and the specificity of the selected material problem.		x	x		x	x	x	x		
80	Pre-Diploma Project D - Nanostructured Polymeric and Composite Materials	The project involves independent development of an issue concerning the properties, structure or technology of nanostructured polymer and composite materials, including analysis of theoretical foundations, selection of appropriate research or analytical methods, performance of necessary tests, and development, interpretation and presentation of results in relation to the design assumptions and the nature of the analyzed material system.		x	x		x	x	x	x		
81	Internship	Introduction to organizational structures, material management practices, production control, safety standards and environmental management within companies and research institutes. Insight into process automation, laboratory work, instrumentation, technologies, standards and the responsibilities of technologists and research team leaders. Problem-solving under the supervision of the internship mentor and development of professional contacts supporting future employment.				x					x	x
82	Legal and Organizational Aspects of Professional Work	Core concepts of labour law, employment regulations, workplace safety and the functioning of institutions and mechanisms governing the employee–employer relationship, elements of entrepreneurship including forms of business activity, registration documentation, financing options, reporting obligations, management principles and fundamentals of workplace communication, foundations of intellectual property and copyright law including national and international protection systems, moral and economic rights, rules of permissible use, issues of plagiarism, the role of technology transfer centres and processes of research results commercialisation.				x					x	x

No.	Course name	Program content	1NAN1	1NAN2	1NAN3	1NAN4	1NAN5	1NAN6	1NAN7	1NAN8	1NAN9	1NAN10
83	Interdisciplinary Project	Independent project development in a small team supported by mentor consultations and guided by Design Thinking, Flipped Learning and Problem Based Learning methods. Creative problem-solving based on needs analysis, idea generation and prototyping within structured project-work principles. Development of teamwork, critical thinking and responsibility for the final outcome.										
84	Nanomaterials and Polymer Nanotechnologies	Nanostructured polymer materials and nano-fillers used to enhance mechanical, barrier, functional and conductive properties in structural, rubber, aerospace and electronic composites. Design of advanced nanocomposites, including biopolymers, recycled-based systems and high-performance coating materials, guided by sustainable-development principles, LCA and carbon-footprint assessment. Laboratory analysis of elastomer dynamics, biocomposite surface energy, anti-graffiti coatings and composting behavior of composite materials.		x						x		
85	Molecular Optoelectronics	Electronic structure of molecular and macromolecular organic materials involving HOMO–LUMO levels, excited states, excitons and charge-transport mechanisms in π-conjugated systems and supramolecular structures such as graphene, fullerenes and carbon nanotubes. Photophysical and electrical processes governing the behavior of conducting, photoconductive and electroluminescent organic materials used in solar cells, OLEDs and field-effect transistors. Laboratory investigation of thin-film conductivity, photoconductivity and performance parameters of organic optoelectronic devices including efficiency, stability and operational lifetime.		x						x		
86	Nanomaterials and Nanotechnologies in Medicine	Nanomedicine involving the types, properties and functions of nanoparticles, nanogels, dendrimers and liposomes used as drug carriers, diagnostic systems and components of tissue engineering and their interactions with biological barriers. Design of polymeric and hybrid materials for therapy, diagnostics, implants and nanosurgery with emphasis on surface characteristics, selectivity, biological reactivity and potential risks. Laboratory work focusing on the synthesis of functional nanostructures, thermoresponsive layers and evaluation of their properties in the context of advanced therapeutic approaches and future medical nanorobotics.										
87	Nanocatalysis and Nanocatalysts	Composition and functions of nanocatalysts based on colloidal nanoparticles, oxide and carbon supports and preparation methods including surfactant-stabilized systems. Structural and surface characterization of heterogeneous nano-catalysts involving mono- and bimetallic systems and nanoporous materials. Analysis of catalytic reaction mechanisms using nanocatalysts together with practical laboratory work on their synthesis and characterization.		x						x		
88	Engineering Laboratory	Individual classes conducted in scientific laboratories of engineering thesis supervisors. Performing experiments related to the diploma thesis topic. Analysis of the obtained research results.										
89	Engineering Diploma Thesis	The structure of the diploma thesis includes defining the objective, scope and rationale of the topic, presenting the theoretical background, and carrying out an experimental or analytical component in which the student independently develops a selected problem using appropriate methods and tools, concluding with the analysis and interpretation of the obtained results in relation to the aims of the work, the formulation of final conclusions, and the preparation of an organised bibliography.										

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	Mathematics I	8				
2	General and Inorganic Chemistry I	6			6	
3	Nanotechnology and Nanoscience	4			4	
4	Information Technology	4			4	
5	Introduction To Data Analysis	4			4	
6	The Art of Studying	2	2			
7	Ecology and Environmental Ethics	2	2	2		
8	History of Chemistry and Chemical Industry	2	2	2		
9	Mathematics II	6				
10	General and Inorganic Chemistry II	7			7	
11	Physics	8			8	
12	Artificial Intelligence and Cybersecurity	3			3	
13	Mechanics and Strength of Materials	4			4	
14	English B2 module I	2		2		
15	English B2+ module I	2		2		
16	English C1 module I	2		2		
17	German B2 module I	2		2		
18	Organic Chemistry	10			10	
19	Analytical Chemistry	5			5	
20	Engineering Design and Graphics	2				

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
21	Ceramic and Metal Nanomaterials	4			4	
22	Polymers and Functional Materials	4			4	
23	Electrical Engineering with Elements of Electronics	3			3	
24	English B2 module II	2		2		
25	English B2+ module II	2		2		
26	English C1 module II	2		2		
27	German B2 module II	2		2		
28	Technology of Polymer Synthesis and Processing	7			7	
29	Quality Management and Normalization	2				2
30	Physical Chemistry	9			9	
31	Instrumental Analysis	4			4	
32	Polymer Nanomaterials	3			3	
33	Design of Products from Polymer Materials	3			3	
34	English B2 module III	2		2		
35	English B2+ module III	2		2		
36	English C1 module III	2		2		
37	German B2 module III	2		2		
38	Solid State Physics	7			7	
39	Process Engineering and Environmental Technologies	3			3	
40	Materials Recycling	2			2	
41	English B2 module IV	3		3		

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
42	English B2+ module IV	3		3		
43	English C1 module IV	3		3		
44	German B2 module IV	3		3		
45	English Technical Terminology and Chemical Scientific Information Sources	3		3		3
46	English Scientific Terminology and Sources of Chemical Scientific Information	3		3		3
47	Polymeric and Engineering Nanomaterials	2		2	2	
48	Radiation Chemistry and Technology of Polymers	2		2	2	
49	Polymeric and Engineering Nanomaterials	7			7	
50	Polymer Radiation Chemistry and Technology	3			3	
51	Polymeric and Engineering Nanomaterials	7			7	
52	Polymer Radiation Chemistry and Technology	3			3	
53	Simulation and Computational Techniques in Chemistry and Nanotechnology	2			2	
54	Summative Module	8		8	8	
55	Smart Polymers	2		2	2	
56	Nanoparticles and the Environment	2		2	2	
57	Ultrasound in Nanotechnology	2		2	2	
58	Conductive Polymeric Nanomaterials	2		2	2	
59	Nanofillers and Nanocomposites	4		4	4	
60	Polymer Materials in Construction	4		4	4	
61	Hybrid Nanocomposites	4		4	4	
62	Supramolecular Chemistry	4		4	4	

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
63	Fundamentals of Crystallography	4		4	4	
64	Basics of Biochemistry	4		4	4	
65	Polymers in Medicine	4		4	4	
66	Thin-Film Technology	4		4	4	
67	Polymers in Transport and Automotive Applications	2		2	2	
68	Nanoparticles, Dispersions, and Polymeric Gels	2		2	2	
69	Operation and Elements of Tribology	2		2	2	
70	Conjugated Polymers	2		2	2	
71	Cosmetic Materials and Nanomaterials	2		2	2	
72	Fundamentals of Adsorption and Catalysis	2		2	2	
73	Elements of Biology and Medicine	2		2	2	
74	Chemistry – Engineering of the Future	2		2	2	
75	Methods of Investigating Engineering Nanomaterials	5		5	5	
76	Methods for the Investigation of Functional Nanomaterials	5		5	5	
77	Pre-Diploma Project A - Nanomaterials in Catalysis and Environmental Protection	7		7	7	
78	Pre-Diploma Project B - Physicochemical and Medical Aspects of Nanotechnology	7		7	7	
79	Pre-Diploma Project C - Synthesis and Technology of Polymeric and Composite Materials	7		7	7	
80	Pre-Diploma Project D - Nanostructured Polymeric and Composite Materials	7		7	7	
81	Internship	6				
82	Legal and Organizational Aspects of Professional Work	3	3			
83	Interdisciplinary Project	1		1		

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
84	Nanomaterials and Polymer Nanotechnologies	2		2	2	
85	Molecular Optoelectronics	2		2	2	
86	Nanomaterials and Nanotechnologies in Medicine	2		2	2	
87	Nanocatalysis and Nanocatalysts	2		2	2	
88	Engineering Laboratory	3			3	
89	Engineering Diploma Thesis	15		15	15	

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)	72/210 (34.29%)
The total number of ECTS credits to be earned by a student through courses in the fields of humanities or social sciences	7
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	166/210 (79.05%)

Methods of verifying and assessing learning outcomes

Learning outcomes are assessed systematically using diverse methods tailored to the nature of each course. These include:

1. Written and oral exams – assessing theoretical knowledge, analytical and problem-solving skills.

2. Quizzes and partial tests – enabling ongoing progress monitoring.

3. Evaluation of projects and laboratory work – assessing practical skills, use of research methods, interpretation of results and teamwork.

4. Presentations and seminars – verifying communication skills, argumentation and presentation of research results.

5. Reports and documentation – assessing data analysis and reporting skills.

6. Competency exam, master’s thesis and defence – providing comprehensive verification of knowledge, skills and social competencies.

7. Activity in discussions and participation in research projects – assessing engagement, independence and teamwork abilities.

Detailed verification methods for each course are included in course syllabi.

Professional internships

6 ECTS; duration of internship: 6 weeks (after Semester IV – 2 weeks of professional internship; after Semester VI – 4 weeks of specialization internship)

Characteristics of the course

Graduate profile

Graduates of the Nanotechnology program possess advanced and well-established knowledge in the fields of chemistry, physics, materials science, and the fundamentals of materials engineering, with particular emphasis on phenomena and processes occurring at the nanoscale. They understand the relationships between the structure, properties, and functionality of nanomaterials and are able to apply this knowledge in selecting appropriate methods for the fabrication and modification of materials.

They have the skills to conduct laboratory experiments, including the synthesis, modification, and fabrication of basic types of nanomaterials, as well as sample preparation for analysis. They are capable of designing and carrying out experiments using appropriate laboratory techniques, while ensuring work safety, data quality, and control of process parameters.

The graduates are able to analyze and interpret research results related to nanomaterials, assess their functional properties, and select suitable manufacturing and processing technologies, taking into account efficiency, safety, and principles of sustainable development. They are capable of operating specialized laboratory equipment used in nanotechnology and selecting appropriate measurement techniques for specific applications.

They are familiar with and apply relevant standards, regulations, and good engineering practices, including those related to safe handling of nanomaterials and assessment of their impact on human health and the environment. In terms of social competencies, they are prepared to communicate effectively in a professional environment, use scientific literature, and work in teams, including interdisciplinary ones. They make decisions that consider technical, economic, legal, and ethical aspects, and demonstrate a readiness to continuously improve their qualifications and engage in lifelong learning.

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

The Nanotechnology programme aligns with the Strategy of Lodz University of Technology for 2025–2030, whose key objective is to develop an educational model preparing graduates for the dynamically changing needs of the socio-economic environment.

The programme supports the following strategic goals:

· Supporting scientific research addressing socio-economic challenges. Nanotechnology students participate in research projects linked to the industrial sector.

· Developing mobility opportunities for staff, doctoral candidates and students. Students and staff regularly take part in international exchanges.

· Expanding internationalisation in education. The Faculty of Chemistry offers courses and seminars in English. A key element of the curriculum is the Research & Development Project, often carried out at a foreign university, institution or company.

· Under the agreement signed between Lodz University of Technology and the University of Twente (UT), students of the Faculty of Chemistry of Lodz University of Technology can obtain a PhD from both universities. The education then comprises four semesters, including one semester of regular classes at UT. The study program also allows for the choice of a track taught in English.

· Conducting useful, socially and environmentally responsible research that supports a knowledge-based economy and fosters interdisciplinary research through the development of collaboration between disciplines and fields of science. Students have the opportunity to conduct research that is linked to industry, responding to social and environmental needs and supporting a knowledge-based economy. The Nanotechnology curriculum is consulted with the Business Council

at the Faculty of Chemistry, ensuring its compliance with the requirements of the labor market.

· Modernizing research infrastructure and developing a system for its rational use. Students of the Faculty of Chemistry at Lodz University of Technology have access to specialized equipment and modern laboratories in the Alchemium building, technological halls, and specialized biomaterials and nanomaterials laboratories.

· Implementing clear and fair principles of employment, remuneration, and career advancement, while taking into account tolerance and equality policies. The recruitment process for employees at the Faculty of Chemistry at Lodz University of Technology is based on the OTM-R policy – "Open, Transparent, and Merit-Based Recruitment Process."

· Continuous improvement of academic teachers' competences in modern teaching methods, the current state of knowledge, technological developments, and trends in science. Academic teachers involved in teaching in the Nanotechnology program actively participate in numerous training courses, improving their qualifications, including in modern teaching methods. Furthermore, they learn modern teaching methods from international specialists visiting the Faculty of Chemistry and participate in teaching at universities abroad.

· Improving the educational offer, including supplementary forms of education, in response to the challenges of the socio-economic environment. The Business Council at the Faculty of Chemistry has a real influence on the shape of the Nanotechnology program, which responds to socio-economic challenges.

· Strengthening the talent management process by individualizing the education paths of students and doctoral students. Talented students can pursue studies according to an individual study program (IPS) or an individual organization of studies (IOS) and participate in TUL's mentoring programs, such as E2TOP and “Uczelnie Przyszłości” (Universities of the Future).

· Supporting the scientific development of students and doctoral students, taking into account interdisciplinarity and internationalization; as well as increasing student participation in research conducted at the university and intensifying their practical experience outside the university. Students have the opportunity to participate in interdisciplinary research projects, for example, combining topics in chemistry, biology, medicine, and materials science. They can also participate in foreign trips and exchange programs, such as Erasmus+, and internships in foreign laboratories. Students also co-author scientific publications with international reach.

Summary: Through these initiatives, the Nanotechnology programme fully aligns with the Strategy of Lodz University of Technology, offering high-quality education and preparing graduates for labour market demands.

Educational objectives and employment and continuing education opportunities

The objective of the Nanotechnology undergraduate program (first-cycle studies) is to prepare graduates for work in the field of design, synthesis, characterization, and application of nanomaterials, as well as technologies based on phenomena occurring at the nanoscale.

The educational objectives are achieved through the development of:

advanced knowledge in chemistry, physics, materials science, and materials engineering, necessary to understand the properties, structure, and functions of nanostructures,
experimental skills, including the synthesis, modification, and fabrication of nanomaterials, as well as planning and performing laboratory experiments,
analytical competencies enabling the selection and application of methods for nanostructure characterization, data analysis, and interpretation of the obtained results,
engineering skills, including risk assessment, technology selection, operation of specialized equipment, and application of safety and sustainable development principles,
social competencies such as teamwork, effective communication in a professional environment, ethical responsibility, and awareness of the impact of nanotechnology on health, the environment, and the economy,
readiness for lifelong learning, continuous professional development, and adaptation to rapidly evolving technologies and labor market requirements.
A graduate of the first-cycle program may continue their education in second-cycle (Master’s) studies in Nanotechnology or related fields, as well as in postgraduate programs related, for example, to advanced materials or innovative technologies integrating nanotechnology with medicine, electronics, and computer science.

The graduate is prepared to work in research and quality control laboratories, companies dealing with advanced materials, nanotechnology, chemical and biotechnological technologies, as well as in industrial sectors utilizing nanomaterials.

They are also prepared to start and run their own business.

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

The Nanotechnology first-cycle (undergraduate) study program assumes systematic cooperation with the socio-economic environment by engaging students in initiatives carried out in collaboration with industrial partners, research institutions, and organizations supporting the development of new technologies.

This cooperation includes participation in problem-based projects aligned with issues typical for industry, study visits, presentations of modern technological solutions delivered by practitioners, and expert consultations addressing current labor market needs.

Through interactions with representatives of the nanotechnology sector, students gain insight into the real technical and organizational conditions of engineering work and develop attitudes that support the responsible and informed use of technology in both social and business contexts.

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

According to the Recruitment Resolution.

The unit organizing education

Faculty of Chemistry

Education program

Semester 1

Course	Number of hours	ECTS points	Form of verification	Obligatory
Mathematics I	Tutorials: 45 Lecture: 45	8	Exam	Obligatory
General and Inorganic Chemistry I	Tutorials: 30 Lecture: 30	6	Exam	Obligatory
Nanotechnology and Nanoscience	Lecture: 60	4	Graded assignment	Obligatory
Information Technology	Laboratory classes: 30 E-learning: 15	4	Graded assignment	Obligatory
Introduction To Data Analysis	Laboratory classes: 30 Lecture: 15	4	Graded assignment	Obligatory
The Art of Studying	Seminar: 5 Lecture: 10	2	Graded assignment	Obligatory
Elective Courses 1		2	Graded assignment	Obligatory group
The student chooses one course from the group.				
Ecology and Environmental Ethics	Seminar: 5 Lecture: 15	2	Graded assignment	Optional
History of Chemistry and Chemical Industry	Seminar: 5 Lecture: 15	2	Graded assignment	Optional
Sum	**335**	**30**		

Semester 2

Course	Number of hours	ECTS points	Form of verification	Obligatory
Mathematics II	Tutorials: 45 Lecture: 45	6	Exam	Obligatory
General and Inorganic Chemistry II	Tutorials: 30 Laboratory classes: 45 Lecture: 15	7	Exam	Obligatory
Physics	Tutorials: 45 Laboratory classes: 40 Lecture: 30	8	Exam	Obligatory
Artificial Intelligence and Cybersecurity	Laboratory classes: 20 Lecture: 15	3	Graded assignment	Obligatory
Mechanics and Strength of Materials	Tutorials: 15 Laboratory classes: 15 Lecture: 30	4	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	**450**	**30**		

Semester 3

Course	Number of hours	ECTS points	Form of verification	Obligatory
Organic Chemistry	Tutorials: 45 Laboratory classes: 60 Lecture: 45	10	Exam	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Analytical Chemistry	Laboratory classes: 45 Lecture: 15	5	Graded assignment	Obligatory
Engineering Design and Graphics	Laboratory classes: 30	2	Graded assignment	Obligatory
Ceramic and Metal Nanomaterials	Laboratory classes: 30 Lecture: 30	4	Graded assignment	Obligatory
Polymers and Functional Materials	Laboratory classes: 15 Lecture: 30	4	Exam	Obligatory
Electrical Engineering with Elements of Electronics	Laboratory classes: 30 Lecture: 15	3	Graded assignment	Obligatory
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	**450**	**30**		

Semester 4

Course	Number of hours	ECTS points	Form of verification	Obligatory
Technology of Polymer Synthesis and Processing	Laboratory classes: 45 Lecture: 40	7	Exam	Obligatory
Quality Management and Normalization	Seminar: 15 Project work: 5 Lecture: 10	2	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Physical Chemistry	Tutorials: 30 Laboratory classes: 60 Lecture: 45	9	Exam	Obligatory
Instrumental Analysis	Laboratory classes: 30 Lecture: 15	4	Graded assignment	Obligatory
Polymer Nanomaterials	Laboratory classes: 25 Lecture: 25	3	Exam	Obligatory
Design of Products from Polymer Materials	Project work: 30 Lecture: 15	3	Graded assignment	Obligatory
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
Physical Education 3	Tutorials: 30	0	Pass	Obligatory
Sum	**450**	**30**		

Semester 5

Course	Number of hours	ECTS points	Form of verification	Obligatory
Solid State Physics	Laboratory classes: 60 Lecture: 40	7	Exam	Obligatory
Process Engineering and Environmental Technologies	Laboratory classes: 15 Lecture: 30	3	Graded assignment	Obligatory
Materials Recycling	Project work: 15 Lecture: 15	2	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
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
English C1 module IV	Tutorials: 30	3	Exam	Optional
German B2 module IV	Tutorials: 30	3	Exam	Optional
Elective Courses 2		3	Graded assignment	Obligatory group
The student chooses one course from the group.				
English Technical Terminology and Chemical Scientific Information Sources	Tutorials: 30 Laboratory classes: 15	3	Graded assignment	Optional
English Scientific Terminology and Sources of Chemical Scientific Information	Tutorials: 30 Laboratory classes: 15	3	Graded assignment	Optional
Elective Courses 3		2	Graded assignment	Obligatory group
The student chooses one course from the group.				
Polymeric and Engineering Nanomaterials	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Radiation Chemistry and Technology of Polymers	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Elective Course Block 1		10	Exam	Obligatory group
The student chooses 1 block.				
Block 1.1		10	Exam	Optional
Polymeric and Engineering Nanomaterials	Laboratory classes: 15 Project work: 15 Lecture: 60	7	Exam	Obowiązkowe w bloku
Polymer Radiation Chemistry and Technology	Laboratory classes: 15 Lecture: 30	3	Exam	Obowiązkowe w bloku
Block 1.2		10	Exam	Optional

Course	Number of hours	ECTS points	Form of verification	Obligatory
Polymeric and Engineering Nanomaterials	Laboratory classes: 15 Project work: 15 Lecture: 60	7	Exam	Obowiązkowe w bloku
Polymer Radiation Chemistry and Technology	Laboratory classes: 15 Lecture: 30	3	Exam	Obowiązkowe w bloku
Sum	**415**	**30**		

Semester 6

Course	Number of hours	ECTS points	Form of verification	Obligatory
Simulation and Computational Techniques in Chemistry and Nanotechnology	Project work: 10 Lecture: 10	2	Graded assignment	Obligatory
Summative Module	Project work: 90	8	Graded assignment	Obligatory subjects to choose from
Elective Courses 4		2	Graded assignment	Obligatory group
The student chooses one course from the group.				
Smart Polymers	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Nanoparticles and the Environment	Project work: 15 Lecture: 15	2	Graded assignment	Optional
Ultrasound in Nanotechnology	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Conductive Polymeric Nanomaterials	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Elective Course 5		4	Exam	Obligatory group
The student chooses one course from the group.				

Course	Number of hours	ECTS points	Form of verification	Obligatory
Nanofillers and Nanocomposites	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Polymer Materials in Construction	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Hybrid Nanocomposites	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Supramolecular Chemistry	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Fundamentals of Crystallography	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Basics of Biochemistry	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Polymers in Medicine	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Thin-Film Technology	Laboratory classes: 30 Lecture: 30	4	Exam	Optional
Elective Courses 6		2	Graded assignment	Obligatory group
The student chooses one course from the group.				
Polymers in Transport and Automotive Applications	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Nanoparticles, Dispersions, and Polymeric Gels	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Operation and Elements of Tribology	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Conjugated Polymers	Project work: 15 Lecture: 15	2	Graded assignment	Optional
Cosmetic Materials and Nanomaterials	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Fundamentals of Adsorption and Catalysis	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional

Course	Number of hours	ECTS points	Form of verification	Obligatory
Elements of Biology and Medicine	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Chemistry – Engineering of the Future	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Elective Courses 7		5	Exam	Obligatory group
The student chooses one course from the group.				
Methods of Investigating Engineering Nanomaterials	Laboratory classes: 60 Lecture: 15	5	Exam	Optional
Methods for the Investigation of Functional Nanomaterials	Laboratory classes: 60 Lecture: 15	5	Exam	Optional
Elective Courses 8		7	Graded assignment	Obligatory group
The student chooses one course from the group.				
Pre-Diploma Project A - Nanomaterials in Catalysis and Environmental Protection	Project work: 90	7	Graded assignment	Optional
Pre-Diploma Project B - Physicochemical and Medical Aspects of Nanotechnology	Project work: 90	7	Graded assignment	Optional
Pre-Diploma Project C - Synthesis and Technology of Polymeric and Composite Materials	Project work: 90	7	Graded assignment	Optional
Pre-Diploma Project D - Nanostructured Polymeric and Composite Materials	Project work: 90	7	Graded assignment	Optional
Sum	**395**	**30**		

Semester 7

Course	Number of hours	ECTS points	Form of verification	Obligatory
Internship	Internship: 0	6	Pass	Obligatory
Legal and Organizational Aspects of Professional Work	Lecture: 60	3	Graded assignment	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Interdisciplinary Project	Project work: 15	1	Graded assignment	Obligatory subjects to choose from
Elective Courses 9		2	Graded assignment	Obligatory group
The student chooses one course from the group.				
Nanomaterials and Polymer Nanotechnologies	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Molecular Optoelectronics	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Nanomaterials and Nanotechnologies in Medicine	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Nanocatalysis and Nanocatalysts	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Engineering Laboratory	Seminar: 15 Laboratory classes: 65	3	Graded assignment + exam	Obligatory
Engineering Diploma Thesis	Diploma Thesis: 0	15	Pass	Obligatory subjects to choose from
Sum	**185**	**30**		