



Lodz University
of Technology

Study programme

Faculty:	Faculty of Biotechnology and Food Sciences
Major:	Bioengineering for Sustainable Development
Level of study:	first-cycle programme (inżynier)
Form of study:	full-time studies
Academic year:	2026/27

Table of contents

Basic information	3
Learning outcomes (in relation to the PQF)	4
Matrix of course modules in relation to learning outcomes and curriculum content	6
ECTS - subjects	14
ECTS indicators	18
Methods of verifying and assessing learning outcomes	19
Professional internships	20
Characteristics of the course	21
Education program	23

Basic information

Name of the field of study:	Bioengineering for Sustainable Development
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:	2670
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:	0712
Language of study:	polish

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

Discipline	Percentage share
Chemical engineering	75%
Food technology and nutrition	25%

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	1BZR1	Knows and understands the basic concepts, mechanisms and relationships in the field of bioengineering, in particular those relating to the biological, biotechnological and engineering processes used in industrial, bioenergy and environmental technologies aimed at sustainable development.	P6U_W	P6S_WG, P6S_WG_inž
2	1BZR10	Is ready to responsibly perform professional roles as a bioengineer, respecting the principles of professional ethics, safety, health and environmental protection.	P6U_K	P6S_KR
3	1BZR2	Knows and understands the principles of sustainable development and the circular economy, including methods for rational management of raw materials and energy, assessment of the environmental impact of technologies, as well as the legal, ethical, economic, and entrepreneurial conditions of engineering practice, encompassing the fundamental principles of establishing and developing various forms of entrepreneurship.	P6U_W	P6S_WK, P6S_WK_inž
4	1BZR3	Is able to plan and carry out experiments in the field of bioengineering, including biological and environmental processes, select equipment, apply advanced information and communication technologies for data acquisition and analysis, analyze results and draw conclusions.	P6U_U	P6S_UW
5	1BZR4	Is able to identify, analyse, and solve typical engineering problems relevant to bioengineering in sustainable development, and to design - according to a given specification - and implement typical bioengineering processes, systems, or simple installations, using appropriately selected methods, techniques, tools, and materials, while taking into account technological requirements as well as environmental constraints.	P6U_U	P6S_UW, P6S_UW_inž
6	1BZR5	Is able to communicate with the environment using specialised terminology in the fields of bioengineering, sustainable development, and the circular economy, including the ability to use a foreign language at B2 level of the Common European Framework of Reference for Languages.	P6U_U	P6S_UK
7	1BZR6	Is able to plan, organize, and carry out individual and team work, as well as collaborate with people with different competencies, creating interdisciplinary solutions in the field of bioengineering and environmentally friendly technologies.	P6U_U	P6S_UO
8	1BZR7	Is able to independently plan and implement own lifelong learning in the field of bioengineering.	P6U_U	P6S_UU
9	1BZR8	Is ready to critically evaluate existing knowledge, responsibly solve bioengineering problems, and use expert opinions.	P6U_K	P6S_KK

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	1BZR9	Is ready to take into account the principles of sustainable development in professional activities and to act for the public interest in the rational management of resources and the implementation of pro-ecological solutions.	P6U_K	P6S_KO

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

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
1	Mathematics I	Elementary functions. Infinite numerical sequences. Properties and limits of sequences. Differential calculus of functions of one variable. Limits of functions. The derivative and its geometric and physical interpretations. Integral calculus of functions of one variable. Fundamental methods of integration.	x			x					x	
2	Physics	Elements of classical mechanics: Principles of dynamics. Inertial and non-inertial reference frames. Conservation laws of momentum and energy, collisions. Dynamics of rigid body motion. Simple, damped, and forced harmonic motion. Electrostatic and magnetic fields.	x			x					x	
3	General and Environmental Chemistry	Basic chemical concepts and laws. Atomic and molecular structure, chemical bonds. Types of chemical reactions, stoichiometry. Chemical equilibria in aqueous solutions and factors influencing their shift. Applications of chemical reactions, including redox, in environmental analytics. Gravimetric and volumetric analysis, redox titrations.	x			x	x		x			
4	Modern IT Technologies, Algorithmization and Cybersecurity	Modern information technologies, including cloud systems, distributed computing, and the application of artificial intelligence in data processing. Fundamentals of algorithm design. Core concepts of cybersecurity: threat models, principles of information protection, network security, and best practices in digital hygiene.				x				x	x	
5	Intro to Bioengineering in Sustainable Development	The concepts of sustainable development, bioeconomy and circular economy. The role of bioengineering in the green transition. Systems approach to environment and economy. Global sustainability challenges. Sustainability strategies and policies in Poland and the EU. Introduction to environmental certification and CSR strategies.			x			x		x		x
6	Basics of Economics and Entrepreneurship	Market. Enterprise and market structures. Factor markets. National income. Aggregate expenditure model. Labour market. Inflation. Conditions for entrepreneurship. Business models. Market analysis. Strategic approach to entrepreneurship. Entrepreneurship and innovation. Investment appraisal. Sources of business financing.			x				x			x
7	Fundamentals of Microbiology with Elements of Cell Biology	Prokaryotic and eukaryotic cell biology. Membrane structure and transport. Microorganism morphology, physiology, growth, metabolism, and role in biogeochemical cycles and biotransformation. Genetic variability, environmental adaptation, identification, classification, and quantification methods.	x			x			x		x	
8	Mathematics II	Partial derivatives. Domain, graph, and extrema of functions of two variables. Double integrals and methods of their evaluation. Geometric interpretation of the double integral. General and particular solutions of differential equations. Elements of probability theory.	x			x					x	
9	Physics with Elements of Biophysics	The phenomenon of electromagnetic induction. Elements of wave optics: electromagnetic waves. Introduction to quantum physics. Elements of quantum optics. Elements of nuclear physics: natural and artificial radioactivity. Alpha, beta, and gamma decay. The statistical law of radioactive decay and activity. Nuclear fusion. Fundamentals of biophysics.	x			x					x	

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
10	Biorganic Chemistry and Biocatalysis	Structure and properties of organic compounds. Major classes of compounds: alcohols, amines, and carboxylic acids. Amino acids, proteins, nucleic acids, carbohydrates, and lipids – their chemical properties and biological functions. Introduction to cellular metabolism and its regulation. Enzymes, classification, and industrial significance	x			x	x		x			
11	Engineering Drawing	Orthogonal projection of model spatial solids. Views and sections. Dimensioning of objects. Drawing simplifications. Drawings of machine elements, both simple and complex. Assembly drawings of technical devices. AutoCAD environment.			x		x		x	x		
12	Environmental Microbiology	Microorganisms in soil, water, and air: their diversity, metabolism (respiration, fermentation, photosynthesis), and nutrient requirements. Their role in element cycling (C, N, S, P). Interdependencies in the environment, biofilms, and their impact on ecosystem quality. Microbiological research methods and their applications in environmental protection and bioengineering.	x			x			x		x	
13	Circular Economy in Process Technologies (CE)	Circular Economy (CE) as a process model – mass, energy, and material flows. Reuse, recovery, recycling, and upcycling in industry. Process balancing for circularity. Examples from various industrial sectors. Case studies: biomass, production waste, waste heat. E-learning component: project – analysis of a simple process from a CE perspective.			x			x		x		x
14	English B2 module I	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
15	English B2+ module I	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
16	German B2 module I	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
17	English C1 module I	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
18	The Art of Engineering Presentation and Communication	Developing skills in public presentation of content related to the engineering profession (lectures, seminars, reports) using appropriate technical means and modern visual aids.						x	x	x	x	
19	Scientist on the Internet	Digital tools supporting a scientist's work: professional social networking platforms, scientific literature search, reference and task management, teamwork, communication, and online presentation of results. Tools for creating graphics, diagrams, and mind maps. Use of AI tools in research and work organization.						x	x	x	x	
20	Creativity and Design Thinking	A course developing students' creativity and design skills using the Design Thinking method. Students identify problems and generate innovative solutions while considering ecological and social aspects.						x	x	x	x	

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
21	Fluid Mechanics and Thermodynamics	The concept of a thermodynamic system, heat, work, energy, enthalpy, entropy. Laws of thermodynamics, thermodynamic processes, water vapor. Basic concepts of fluid mechanics. Forces acting in fluids. Mass and momentum balance of a fluid. Laminar and turbulent flow, similarities of flow phenomena. The Bernoulli equation.	x			x			x		x	
22	Analysis and Certification in Agricultural and Food Production	Food quality and safety control techniques and tools; selection of monitoring methods appropriate for the product and GLOBAL G.A.P., ISO and HACCP requirements. Preparation of samples for analysis, validation and calibration of equipment, assessment of precision, measurement uncertainty and compliance with standards. The role of standards, audits, HACCP and GMP/GHP practices.	x			x		x			x	
23	Industrial Bioengineering	Development and organization of bioengineering processes at an industrial scale; characteristics of industrial microorganisms. Operation of bioreactors (optimization, scale-up, monitoring); production and purification of bioproducts. Examples of industrial bioengineering products, legal and ethical aspects.	x			x			x		x	
24	Design of Process Installations	Process documentation and design of installations for bioprocesses and sustainable technologies. Material and energy balances, process flow diagrams, assessment of production impact on quality, efficiency, and the environment. Equipment layout, utilities, storage, transport, process safety, and sustainable land-use planning.			x		x		x			x
25	English B2 module II	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
26	English B2+ module II	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
27	German B2 module II	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
28	English C1 module II	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
29	Modern Methods of Control in Industry	Instrumental analysis in process control (FTIR/NIR/MIR, HPLC chromatography, GC-MS, electrochemical methods). Methods of detection and identification of microorganisms using molecular methods. Control of physicochemical properties of products. Analysis of adulterations. Technology-assisted sensory control.	x			x		x			x	
30	Application of Chromatographic Techniques in Monitoring Bioprocesses	Use of chromatographic methods (gas chromatography and high-performance liquid chromatography) for monitoring bioprocesses: analysis of raw materials, metabolites, inhibitors, and contaminants; determination of process indicators; statistical analysis of data.	x			x		x			x	
31	Renewable Raw Materials Market	Definition and global market for renewable raw materials; definition and types of biomass. Overview of the composition of biomass. Current trends in biomass use (production of fuels, energy and chemicals). Availability of biomass in Poland and the EU. Cultivation of genetically modified plants. General information about waste and its segregation.	x				x		x		x	

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
32	Environmental Adaptation and Climate Innovation	Protection of biodiversity and its role in the functioning of ecosystems and the economy. Climate change challenges and adaptation methods in various sectors. Climate risk assessment methods, analysis of ecosystem and infrastructure vulnerability, adaptation planning, and solutions based on nature and blue-green infrastructure.	x				x		x		x	
33	Hydrogen Technologies and Microbial Fuel Cells	Theoretical and design fundamentals of microbial fuel cells, mechanisms of biological energy conversion, and the potential of microorganisms for hydrogen and electricity production; aspects of design and optimization of energy bioprocesses; selection of microorganisms, reaction conditions, and assessment of energy efficiency.	x				x		x		x	
34	Artificial Intelligence Industrial Biotechnology	Applications of AI in industrial biotechnology, biological data analysis, and process automation. Predictive models, design of computer vision-based solutions, and development of AI concepts that improve production processes.	x	x				x		x		
35	Prospects for the Application of Artificial Intelligence in Environmental Protection	Use of AI in environmental monitoring, analysis of images and measurement data, and support for ecological decision-making. Simple predictive systems, use of AI for environmental quality assessment, and development of solution concepts supporting sustainable development.	x	x				x		x		
36	Introduction to LCA and Environmental Footprints	Life Cycle Assessment (LCA) – concepts and methods in the context of sustainable development. Software, databases, and principles for identifying and quantifying environmental impacts. Carbon, water, and material footprint analysis and Interpretation of results. LCA applications in the design of sustainable products and industrial processes.			x		x					x
37	Bioprocess Engineering and Equipment	Unit operations, bioreactor theory (ideal/non-ideal). Construction and application of laboratory and industrial bioreactors; photobioreactors; bioreactors for gas and wastewater treatment. Batch/continuous cultures, mass balances. Mass and heat transfer, fluid mechanics. Membrane methods. Designing process lines, equipment selection.	x		x	x	x					
38	Sustainable Production and Bioenergy Technologies	Modern technologies for raw material processing and energy generation. Biorefineries. First, second, and third-generation biofuel production technologies. Energy utilization of biowaste (anaerobic digestion of agri-food waste, biogas and biomethane); composting, biogas plants, bio-upcycling. Biohydrogen. Biological methods for plastics recycling.	x			x	x					x
39	Genetics and Biosafety of Industrial Microorganisms	Basic concepts and methods used in genetic engineering and its industrial applications. Principles of working with genetically modified microorganisms, biosafety, hazard classification, good laboratory practices, legal regulations, usage requirements, and ethical and environmental aspects in bioengineering.	x	x	x	x						
40	PBL Project	Problem analysis. Developing a solution — searching for and selecting possible options, choosing the best solutions, prototyping, testing/evaluation.					x	x	x		x	
41	English B2 module III	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
42	English B2+ module III	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
43	German B2 module III	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
44	English C1 module III	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
45	Bioprocesses Based on Unconventional Organisms	Use of microorganisms sourced from unconventional environments in modern, sustainable bioprocesses; their potential as sources of innovative biocatalysts supporting the circular economy; application in processes utilizing waste and feedstocks that are difficult to process using traditional methods.			x		x					x
46	Nanobiotechnology	Introduction to nanobiotechnology. Structure, properties, and functions of nanomaterials such as nanoparticles, nanofibers, liposomes, and biopolymers; methods for synthesizing and modifying nanomaterials; their applications in medicine, pharmacy, and environmental protection; safety and ethical issues related to the use of nanobiotechnology.			x		x					x
47	Industry 5.0 and Human-centric Design	The concept of Industry 5.0, focused on integrating advanced industrial technologies with human needs and sustainability principles. Human-robot collaboration (cobots), user-centered design of processes and products, and production personalization while maintaining efficiency and safety.			x		x					x
48	Algae and Plant Biotechnology in Sustainable Development	The use of algae and plants in biotechnology, the production of bioactive compounds, biofuels, bioplastics, and environmental protection. Methods of cultivation and metabolic engineering of algae and plants, analysis of their metabolites, and their potential applications in the pharmaceutical and cosmetic industries, agriculture, and energy.	x			x						x
49	Phytoremediation and Biofiltration	Modern methods of environmental remediation using plants and microorganisms. Mechanisms for removing pollutants from soil, water, and air. Analysis of the effectiveness of different plant species and microorganisms in phytoremediation processes, as well as the design and testing of simple biofiltration systems.	x			x						x
50	Environmental Audit	Planning, conducting, and evaluating environmental audits; verifying environmental management systems (ISO 14001 and EMAS; ISO 50001, ISO 14064). Developing audit reports, formulating recommendations, and verifying corrective actions (economic, ecological, and strategic aspects). Conducting internal examinations and certification.			x				x		x	x
51	ESG Strategies and Reporting in Sustainable Bioenergy	Integration of environmental, social, and governance (ESG) principles into the design and management of bioenergy enterprises, focusing on ESG strategy development, greening processes, and sustainable development reporting. Includes meetings with experts and industry professionals.			x		x		x			x

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
52	Ecotoxicology and Environmental Monitoring	Toxic substances contaminating the environment. Xenobiotics. Mutagenicity, carcinogenicity, teratogenicity. Biological methods for contamination assessment: bioindication, biotests, and ecotoxicological tests using model test organisms and indicator species. Ecotoxicological risk assessment.	x			x				x	x	
53	Water Resource Management and Water Recovery	Modern approaches to the protection and efficient use of water resources in the context of climate change and increasing water demand. Basics of hydrology. Water recovery and reuse technologies. EU water management regulations. Case study analysis and design of sustainable water systems.			x		x		x			x
54	Statistics and Data Analysis	Descriptive statistics and visualization of experimental data. Estimation of population parameters. Hypothesis testing regarding population parameters and distribution forms. Correlation and regression analysis. Fundamentals of experimental design. Use of specialized software supporting statistical analysis.	x			x				x	x	
55	Design and Technologies of Eco-friendly Packaging	Eco-friendly packaging and its importance for the circular economy. History and evolution of packaging design. Strategies for developing environmentally friendly materials, raw materials, production technologies, recycling, and reuse. Current packaging regulations and reporting.			x	x				x		x
56	English B2 module IV	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
57	English B2+ module IV	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
58	German B2 module IV	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
59	English C1 module IV	Selected lexical and grammatical topics, as well as language themes and contexts characteristic of the learning and professional environment of a university graduate.						x	x		x	
60	Biosensors and Biomaterials	Modern technologies combining biology and materials engineering. Structure and function of biosensors, the role of bioreceptors, and types of transducers used in detecting biological signals. Key groups of biomaterials and principles of their biocompatibility and interaction with the body. Overview of biosensor and biomaterial applications.	x			x						x
61	Improving Industrial Microbes	Obtaining strains of microorganisms with specific biological activity. Stabilisation and improvement of technological characteristics through mutagenesis, physical and chemical methods. Screening of strains from the environment on microbiological media and characterisation of isolates in terms of morphology and physiology.	x			x						x
62	Sustainable Pharmaceutical Technologies and Biopharmaceuticals	Modern, environmentally friendly methods of drug design, synthesis, and delivery. Principles of green pharmaceutical chemistry. Biotherapeutics, drug nanocarriers, and controlled drug release technologies. Environmental safety of pharmaceuticals, their impact on ecosystems, and principles of designing biocompatible materials.	x			x						x

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
63	Energy from Inexhaustible Resources	Wind energy. Energy conversion in a wind turbine. Wind power plants. Solar energy. Methods of converting solar radiation: photovoltaic conversion, photothermal conversion, photochemical conversion. Solar power plants and solar collectors.			x	x	x					x
64	Biological Data Analysis with Elements of Bioinformatics	Bioinformatics in the analysis of data on microorganisms, enzymes and bioconversion, and the assessment of sustainable technology parameters. Tools for analysing large sets of process and environmental data, visualising trends in bioprocesses, bioreactor performance, emissions, raw material recovery and waste degradation in the circular economy.	x			x				x	x	
65	Summative Block	Planning and financing research, commercializing results, implementing products, assessing their environmental impact. Project management in the context of circular economy and ESG. Interdisciplinary teamwork – utilizing knowledge of project management, LCA, standardization, ESG. Project implementation verifies the achieved learning outcomes.			x		x	x	x		x	
66	Lean & Green Engineering	Integration of Lean Management principles with sustainability concepts. Design of processes with minimal consumption of resources, energy, and materials. Tools for waste elimination and process optimization methods that incorporate environmental impact reduction.			x		x	x				x
67	Safety of Work and Ergonomics	Legal protection of work. Contemporary concepts of occupational health and safety management. Safety indicators. Standardization of systems. Occupational risk assessment. Economic aspects of management. Safety and health culture. The human-product (environment) system as the subject of ergonomics research. Corrective and conceptual ergonomics, and specialized ergonomics.		x	x						x	
68	Career Paths in Bioengineering	Practical aspects of the operation of companies using bioprocesses, start-ups, and research institutions. Meetings with experts and entrepreneurs who share their experience in innovation implementation, project management, and bioproduct development. Panel discussions, case study presentations, workshops, and Oxford-style debates.		x				x		x	x	
69	Ethics for Bioengineers	Ethical dilemmas in contemporary bioengineering – technology analysis (genetic engineering, genome synthesis, nanobiotechnology, AI in biology). Biosecurity, data protection, environmental interference, and organismal well-being. Critical analysis of sources, evidence-based discourse, Oxford discussions. Case studies.		x				x		x	x	
70	Bioremediation and Reclamation of Degraded Areas	Biological methods for restoring the quality of soils and degraded areas; bioremediation strategies; selection of cleanup strategies; regulations and standards regarding permissible contaminant content in soils; methods for assessing the effectiveness of remediation. Fieldwork (soil sampling, analysis of soil condition before and after the remediation process).	x		x	x	x					x
71	Modern Methods of Biodegradation in Aquatic Ecosystems	Modern methods of pollutant degradation in aquatic environments; bioremediation strategies in aquatic ecosystems, biodegradation mechanisms, and factors influencing the effectiveness of biological processes. Monitoring. Field activities (water and sediment sampling, analysis of water quality and biodegradation efficiency).	x		x	x	x					x

No.	Course name	Program content	1BZR1	1BZR10	1BZR2	1BZR3	1BZR4	1BZR5	1BZR6	1BZR7	1BZR8	1BZR9
72	Sustainable Rreporting and ESG Practices - Design Laboratory	Practical development of environmental reports and ESG strategies. Case studies. Methods for collecting and analyzing environmental data, developing ESG indicators, and developing recommendations for improving sustainability performance, including aspects of environmental certification, reporting standards, and regulatory compliance.			x	x	x					x
73	Sustainable Processes for Manufacturing Innovative Products - Design Laboratory	Practical development of innovative, sustainable products for various industrial sectors. The course is conducted using a Case Teaching approach, working with real-world and simulated cases related to the design and optimization of new products. The course also covers aspects of environmental protection and ecological certification.			x	x	x					x
74	Internship in sustainable reporting	Practical application of knowledge gained from studies in the area of sustainable development and ESG reporting. Familiarization with the company's organizational structure, legal regulations, and procedures for preparing non-financial reports. Development of analytical skills and social competencies necessary for work in ESG reporting and sustainable management.		x		x	x		x		x	
75	Internship in bioengineering of industrial processes	Practical application of knowledge in industrial bioengineering and sustainable development. Familiarization with company structure, legal regulations, and work procedures in laboratories, production lines, and bioengineering installations. Development of practical, analytical, and social skills essential in the biotechnology industry.		x		x	x		x		x	
76	Diploma Seminar	Preparation and presentation of a literature review related to the topic of the diploma thesis, including the assumptions, scope, and approach to solving the research problem, research methodology, presentation of research results, and their discussion.	x		x			x			x	
77	Final Project	Familiarizing diploma students with the techniques for preparing a thesis. Students collect literature related to their thesis topic, develop a research methodology, conduct experiments, process results, write the thesis, and present it in both printed and electronic versions.	x		x	x	x				x	
78	Graduates on the Job Market	Career planning. Social competencies required in the labor market. Self-presentation techniques. Meetings with industry representatives and recruitment specialists, enabling students to become familiar with labor market requirements, employer expectations, and the realities of the recruitment process.		x				x		x		
79	Initiatives for the Socioeconomic Environment	Building an organization's relationships with its surroundings. Mapping stakeholders of the organization, including universities. Methods of communication and interaction with representatives of the environment of different ages and representing various entities. Identification of educational needs regarding the implementation of pro-environmental solutions.		x				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	Mathematics I	7				
2	Physics	2				
3	General and Environmental Chemistry	8			8	
4	Modern IT Technologies, Algorithmization and Cybersecurity	2				
5	Intro to Bioengineering in Sustainable Development	2			2	
6	Basics of Economics and Entrepreneurship	3	3			
7	Fundamentals of Microbiology with Elements of Cell Biology	6			6	
8	Mathematics II	7				
9	Physics with Elements of Biophysics	4				
10	Biorganic Chemistry and Biocatalysis	7			7	
11	Engineering Drawing	2				
12	Environmental Microbiology	3			3	
13	Circular Economy in Process Technologies (CE)	3			3	
14	English B2 module I	2		2		
15	English B2+ module I	2		2		
16	German B2 module I	2		2		
17	English C1 module I	2		2		
18	The Art of Engineering Presentation and Communication	2		2		
19	Scientist on the Internet	2		2		
20	Creativity and Design Thinking	2		2		

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
21	Fluid Mechanics and Thermodynamics	6			6	
22	Analysis and Certification in Agricultural and Food Production	5			5	
23	Industrial Bioengineering	8			8	
24	Design of Process Installations	3				
25	English B2 module II	2		2		
26	English B2+ module II	2		2		
27	German B2 module II	2		2		
28	English C1 module II	2		2		
29	Modern Methods of Control in Industry	2		2	2	
30	Application of Chromatographic Techniques in Monitoring Bioprocesses	2		2	2	
31	Renewable Raw Materials Market	2		2	2	
32	Environmental Adaptation and Climate Innovation	2		2	2	
33	Hydrogen Technologies and Microbial Fuel Cells	2		2	2	
34	Artificial Intelligence Industrial Biotechnology	2		2	2	
35	Prospects for the Application of Artificial Intelligence in Environmental Protection	2		2	2	
36	Introduction to LCA and Environmental Footprints	3			3	
37	Bioprocess Engineering and Equipment	7			7	
38	Sustainable Production and Bioenergy Technologies	8			8	
39	Genetics and Biosafety of Industrial Microorganisms	3			3	
40	PBL Project	2		2		
41	English 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
42	English B2+ module III	2		2		
43	German B2 module III	2		2		
44	English C1 module III	2		2		
45	Bioprocesses Based on Unconventional Organisms	2		2	2	
46	Nanobiotechnology	2		2	2	
47	Industry 5.0 and Human-centric Design	2		2	2	
48	Algae and Plant Biotechnology in Sustainable Development	3		3	3	
49	Phytoremediation and Biofiltration	3		3	3	
50	Environmental Audit	5			5	
51	ESG Strategies and Reporting in Sustainable Bioenergy	4			4	
52	Ecotoxicology and Environmental Monitoring	3			3	
53	Water Resource Management and Water Recovery	7			7	
54	Statistics and Data Analysis	3				
55	Design and Technologies of Eco-friendly Packaging	3			3	
56	English B2 module IV	3		3		
57	English B2+ module IV	3		3		
58	German B2 module IV	3		3		
59	English C1 module IV	3		3		
60	Biosensors and Biomaterials	2		2	2	
61	Improving Industrial Microbes	2		2	2	
62	Sustainable Pharmaceutical Technologies and Biopharmaceuticals	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
63	Energy from Inexhaustible Resources	4				
64	Biological Data Analysis with Elements of Bioinformatics	3			3	
65	Summative Block	8			8	
66	Lean & Green Engineering	3			3	3
67	Safety of Work and Ergonomics	4	4			
68	Career Paths in Bioengineering	2	2	2		
69	Ethics for Bioengineers	2	2	2		
70	Bioremediation and Reclamation of Degraded Areas	6		6	6	
71	Modern Methods of Biodegradation in Aquatic Ecosystems	6		6	6	
72	Sustainable Rreporting and ESG Practices - Design Laboratory	3		3		
73	Sustainable Processes for Manufacturing Innovative Products - Design Laboratory	3		3		
74	Internship in sustainable reporting	6		6		
75	Internship in bioengineering of industrial processes	6		6		
76	Diploma Seminar	2			2	
77	Final Project	15			15	
78	Graduates on the Job Market	2	2			
79	Initiatives for the Socioeconomic Environment	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)	43/210 (20.48%)
The total number of ECTS credits to be earned by a student through courses in the fields of humanities or social sciences	13
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	141/210 (67.14%)

Methods of verifying and assessing learning outcomes

The verification of achieved learning outcomes requires the use of diverse assessment methods appropriate to the categories of knowledge, skills, and social competencies to which these outcomes pertain. The selection of suitable tools also depends on the specific nature of the subject and the format of the classes and is described in detail in the course syllabi. The achievement of the required learning outcomes is assessed through:

1. Written assignments (exams, quizzes, reports, essays, projects, posters, thesis, etc.);
2. Oral assessments (oral exams, public speaking, e.g., delivering a paper, presentation, etc.);
3. Practical and/or project-based tasks (both individual and group work);
4. Observation and evaluation of students' participation and activity during classes;
5. Self-assessment and peer evaluation (especially in the case of group projects);
6. Competency exams and final diploma examinations.

Verification can be formative (partial, conducted multiple times during the course) and/or summative (final grade assessment). The final verification result is given according to the currently applicable grading scale.

The course coordinator or instructor is required to present the course syllabus during the first class and to clearly define and formally communicate the assessment methods and conditions for verifying learning outcomes.

Professional internships

Duration: 6 weeks

ECTS credits: 6

Internships are carried out in accordance with the study program in a format adapted to the profile and specifics of the field of study, following the regulations set by the faculty and the university.

Characteristics of the course

Graduate profile

A graduate of the Bioengineering for Sustainable Development program possesses interdisciplinary knowledge in the fields of engineering, natural sciences, environmental sciences, as well as management and economics, enabling the design, implementation, and evaluation of modern environmentally friendly technologies. They understand the principles of the circular economy and strategies for reducing the negative impact of human activity on ecosystems. The graduate has expertise in the rational management of resources and energy (including water and energy conservation, as well as the application of closed-loop systems in industrial technologies) and in the utilization of waste materials as secondary resources. They demonstrate advanced knowledge in microbiology, biotechnology, bioprocess engineering, bioenergetics, environmental protection, and food technology, and are capable of applying modern engineering and digital tools for the analysis, modeling, and optimization of biological and technological processes. Furthermore, the graduate is familiar with current legal regulations, environmental management standards, principles of ecological certification, and sustainability reporting, which prepares them to obtain relevant industry certifications.

The graduate is able to work effectively in interdisciplinary teams, uses professional and technical terminology, and possesses fundamental skills in data analysis and the application of digital tools in environmental and process engineering. They are prepared for employment in the biotechnology, chemical, food, pharmaceutical, energy, and environmental sectors, as well as in research institutions, certification laboratories, public administration, consulting firms, or for establishing their own business, particularly in the field of green technologies.

They demonstrate engineering, social, and ethical competencies that enable responsible decision-making in line with the principles of sustainable development. The graduate is also prepared to continue their education at the second-cycle (Master's) level. They exhibit adaptability to a dynamic work environment, readiness to undertake challenges related to technological innovation, and the ability to develop solutions supporting environmental protection.

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

The Bioengineering for Sustainable Development study program is aligned with the mission and development strategy of the University. The implementation of a modern curriculum ensures the education of highly qualified professionals prepared to work in the biotechnology, chemical, food, pharmaceutical, and energy sectors, as well as in research institutions, public administration, and consulting firms. The core idea of the program is not only to provide specialized knowledge in the fields of bioengineering, bioprocesses, environmental protection, and sustainable development, but above all to develop creative and innovative thinking skills, enabling graduates to design, implement, and evaluate environmentally friendly technological solutions.

The curriculum fosters competencies in the cooperation between science and industry, the application of digital tools, sustainability reporting (including ESG and LCA), and ecological certification. Education is oriented toward understanding and implementing modern technologies, sustainable resource management, and funding mechanisms for pro-innovation activities, as well as supporting the development of knowledge and innovation awareness among entrepreneurs and society. Students will also develop consulting and analytical competencies necessary for making informed decisions in accordance with the principles of sustainable development. The program reflects the University's strategic objectives in terms of individualized education, among others through a broad offer of elective courses. This approach enables students to develop competencies aligned with their interests as well as the needs of the labor market.

Educational objectives and employment and continuing education opportunities

A graduate of the first-cycle (Bachelor's) degree program in Bioengineering for Sustainable Development will be distinguished by an interdisciplinary education and competencies enabling flexible functioning in the labor market. The program aims to prepare graduates to acquire:

1. knowledge and skills necessary for the design, implementation, and evaluation of production and technological processes in the field of bioengineering and the processing of renewable natural resources, in accordance with the principles of sustainable development, including the production of energy, biofuels, food, and other industrial products, while taking into account environmental, economic, and legal aspects;
2. knowledge and practical competencies in sustainable resource management, the use of renewable energy sources, waste management, recycling, and the reduction of the environmental impact of human activity, including through life cycle assessment (LCA) and ESG reporting;

3. the ability to integrate knowledge from the fields of chemical engineering, microbiology, biotechnology, bioeconomy, environmental protection, food technology, as well as the design of processes and systems within a circular economy framework, including consideration of economic aspects, legal regulations, and intellectual property management, enabling the development of innovative and improved technological solutions;
4. skills in acquiring and managing national and European funds, as well as their application in pro-innovation, research, and entrepreneurial projects in the field of sustainable development and green technologies.

The program prepares graduates to acquire knowledge and competencies enabling them to take examinations and obtain certifications in environmental management systems, eco-labeling of products, certification in the food and biotechnology sectors, as well as life cycle assessment (LCA), ESG reporting, and the management of certification procedures.

Graduates will be prepared to work in enterprises, laboratories, and research institutions, as well as to implement pro-innovation projects and green technologies. They will also be prepared to continue their education at the second-cycle (Master's) level, develop their professional skills through postgraduate studies and training courses, and, thanks to the education acquired, establish their own business activity and adapt effectively to the evolving demands of the labor market.

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

The socio-economic environment provides an assessment of the proposed study program in terms of the expectations and requirements placed on graduates entering the labor market. A request for opinions was addressed to a group of external stakeholders representing professional sectors related to the proposed field of study and the achievement of its learning outcomes.

The following companies acted in an advisory capacity during the process of developing, reviewing, and evaluating the study program:

1. Polmos Żyrardów Sp. z o.o.
2. Biotechnika Poland Sp. z o.o.

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

In accordance with the admission resolution for a given academic year.

The unit organizing education

Faculty of Biotechnology and Food Sciences

Education program

Semester 1

Course	Number of hours	ECTS points	Form of verification	Obligatory
Mathematics I	Tutorials: 60 Lecture: 30	7	Graded assignment	Obligatory
Physics	Tutorials: 15 Lecture: 15	2	Graded assignment	Obligatory
General and Environmental Chemistry	Tutorials: 30 Laboratory classes: 45 Lecture: 30	8	Exam	Obligatory
Modern IT Technologies, Algorithmization and Cybersecurity	Laboratory classes: 30 E-learning: 15	2	Graded assignment	Obligatory
Intro to Bioengineering in Sustainable Development	Seminar: 20 Lecture: 10	2	Graded assignment	Obligatory
Basics of Economics and Entrepreneurship	Tutorials: 20 Lecture: 30	3	Graded assignment	Obligatory
Fundamentals of Microbiology with Elements of Cell Biology	Laboratory classes: 45 Lecture: 30	6	Exam	Obligatory
Sum	425	30		

Semester 2

Course	Number of hours	ECTS points	Form of verification	Obligatory
Mathematics II	Tutorials: 60 Lecture: 30	7	Exam	Obligatory
Physics with Elements of Biophysics	Laboratory classes: 30 Lecture: 15	4	Exam	Obligatory

Course	Number of hours	ECTS points	Form of verification	Obligatory
Biorganic Chemistry and Biocatalysis	Laboratory classes: 55 Project work: 10 Lecture: 30	7	Exam	Obligatory
Engineering Drawing	Project work: 30	2	Graded assignment	Obligatory
Environmental Microbiology	Laboratory classes: 30 Lecture: 30	3	Graded assignment	Obligatory
Circular Economy in Process Technologies (CE)	Tutorials: 20 Seminar: 10 E-learning: 10	3	Graded assignment	Obligatory
Foreign Language Module 1		2	Graded assignment	Obligatory group
The student chooses 1 module				
English B2 module I	Tutorials: 30	2	Graded assignment	Optional
English B2+ module I	Tutorials: 30	2	Graded assignment	Optional
German B2 module I	Tutorials: 30	2	Graded assignment	Optional
English C1 module I	Tutorials: 30	2	Graded assignment	Optional
Physical Education 1	Tutorials: 30	0	Pass	Obligatory
Elective Courses 1		2	Graded assignment	Obligatory group
The student chooses 1 subject				
The Art of Engineering Presentation and Communication	Project work: 30	2	Graded assignment	Optional
Scientist on the Internet	E-learning: 30	2	Graded assignment	Optional
Creativity and Design Thinking	Project work: 30	2	Graded assignment	Optional
Sum	450	30		

Semester 3

Course	Number of hours	ECTS points	Form of verification	Obligatory
Fluid Mechanics and Thermodynamics	Tutorials: 15 Laboratory classes: 15 Lecture: 30	6	Exam	Obligatory
Analysis and Certification in Agricultural and Food Production	Laboratory classes: 50 Lecture: 20	5	Graded assignment	Obligatory
Industrial Bioengineering	Laboratory classes: 55 Project work: 15 Lecture: 30	8	Exam	Obligatory
Design of Process Installations	Project work: 30 Lecture: 15	3	Graded assignment	Obligatory
Foreign Language Module 2		2	Graded assignment	Obligatory group
The student chooses 1 module				
English B2 module II	Tutorials: 30	2	Graded assignment	Optional
English B2+ module II	Tutorials: 30	2	Graded assignment	Optional
German B2 module II	Tutorials: 30	2	Graded assignment	Optional
English C1 module II	Tutorials: 30	2	Graded assignment	Optional
Physical Education 2	Tutorials: 30	0	Pass	Obligatory
Elective Courses 2		2	Graded assignment	Obligatory group
The student chooses 1 subject				
Modern Methods of Control in Industry	Laboratory classes: 20 Lecture: 20	2	Graded assignment	Optional
Application of Chromatographic Techniques in Monitoring Bioprocesses	Laboratory classes: 35 Lecture: 5	2	Graded assignment	Optional
Elective Courses 3		2	Graded assignment	Obligatory group
The student chooses 1 subject				
Renewable Raw Materials Market	Project work: 20 Lecture: 10	2	Graded assignment	Optional

Course	Number of hours	ECTS points	Form of verification	Obligatory
Environmental Adaptation and Climate Innovation	Project work: 20 Lecture: 10	2	Graded assignment	Optional
Hydrogen Technologies and Microbial Fuel Cells	Project work: 20 Lecture: 10	2	Graded assignment	Optional
Elective Courses 4		2	Graded assignment	Obligatory group
The student chooses 1 subject				
Artificial Intelligence Industrial Biotechnology	Laboratory classes: 20 Lecture: 15	2	Graded assignment	Optional
Prospects for the Application of Artificial Intelligence in Environmental Protection	Laboratory classes: 20 Lecture: 15	2	Graded assignment	Optional
Sum	440	30		

Semester 4

Course	Number of hours	ECTS points	Form of verification	Obligatory
Introduction to LCA and Environmental Footprints	Tutorials: 20 Lecture: 10	3	Exam	Obligatory
Bioprocess Engineering and Equipment	Laboratory classes: 20 Project work: 30 Lecture: 30	7	Exam	Obligatory
Sustainable Production and Bioenergy Technologies	Laboratory classes: 90 Lecture: 30	8	Exam	Obligatory
Genetics and Biosafety of Industrial Microorganisms	Laboratory classes: 20 Project work: 20 Lecture: 15	3	Graded assignment	Obligatory
PBL Project	Project work: 30	2	Graded assignment	Obligatory subjects to choose from
Foreign Language Module 3		2	Graded assignment	Obligatory group

Course	Number of hours	ECTS points	Form of verification	Obligatory
The student chooses 1 module				
English B2 module III	Tutorials: 30	2	Graded assignment	Optional
English B2+ module III	Tutorials: 30	2	Graded assignment	Optional
German B2 module III	Tutorials: 30	2	Graded assignment	Optional
English C1 module III	Tutorials: 30	2	Graded assignment	Optional
Physical Education 3	Tutorials: 30	0	Pass	Obligatory
Elective Course 5		2	Graded assignment	Obligatory group
The student chooses 1 subject				
Bioprocesses Based on Unconventional Organisms	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Nanobiotechnology	Laboratory classes: 15 Project work: 10 Lecture: 5	2	Graded assignment	Optional
Industry 5.0 and Human-centric Design	Project work: 15 Lecture: 15	2	Graded assignment	Optional
Elective Courses 6		3	Graded assignment	Obligatory group
The student chooses 1 subject				
Algae and Plant Biotechnology in Sustainable Development	Laboratory classes: 30 Lecture: 15	3	Graded assignment	Optional
Phytoremediation and Biofiltration	Laboratory classes: 30 Lecture: 15	3	Graded assignment	Optional
Sum	450	30		

Semester 5

Course	Number of hours	ECTS points	Form of verification	Obligatory
Environmental Audit	Project work: 30 Lecture: 20 E-learning: 10	5	Exam	Obligatory
ESG Strategies and Reporting in Sustainable Bioenergy	Tutorials: 20 Project work: 20 Lecture: 10	4	Graded assignment	Obligatory
Ecotoxicology and Environmental Monitoring	Laboratory classes: 30 Lecture: 15	3	Graded assignment	Obligatory
Water Resource Management and Water Recovery	Laboratory classes: 45 Project work: 15 Lecture: 20	7	Graded assignment	Obligatory
Statistics and Data Analysis	Tutorials: 45	3	Graded assignment	Obligatory
Design and Technologies of Eco-friendly Packaging	Laboratory classes: 20 Lecture: 20	3	Graded assignment	Obligatory
Foreign Language Module 4		3	Exam	Obligatory group
The student chooses 1 module				
English B2 module IV	Tutorials: 30	3	Exam	Optional
English B2+ module IV	Tutorials: 30	3	Exam	Optional
German B2 module IV	Tutorials: 30	3	Exam	Optional
English C1 module IV	Tutorials: 30	3	Exam	Optional
Elective Courses 7		2	Graded assignment	Obligatory group
The student chooses 1 subject				
Biosensors and Biomaterials	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Improving Industrial Microbes	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Sustainable Pharmaceutical Technologies and Biopharmaceuticals	Laboratory classes: 15 Lecture: 15	2	Graded assignment	Optional
Sum	380	30		

Semester 6

Course	Number of hours	ECTS points	Form of verification	Obligatory
Energy from Inexhaustible Resources	Laboratory classes: 20 Seminar: 10 Lecture: 20	4	Exam	Obligatory
Biological Data Analysis with Elements of Bioinformatics	Tutorials: 30 Lecture: 15	3	Graded assignment	Obligatory
Summative Block	Project work: 105	8	Graded assignment	Obligatory
Lean & Green Engineering	Tutorials: 20 Lecture: 15	3	Graded assignment	Obligatory
Safety of Work and Ergonomics	Tutorials: 20 Lecture: 20	4	Exam	Obligatory
Elective Courses 8		2	Graded assignment	Obligatory group
The student chooses 1 subject				
Career Paths in Bioengineering	Project work: 30	2	Graded assignment	Optional
Ethics for Bioengineers	Project work: 30	2	Graded assignment	Optional
Elective Courses 9		6	Graded assignment	Obligatory group
The student chooses 1 subject				
Bioremediation and Reclamation of Degraded Areas	Laboratory classes: 40 Project work: 20 Lecture: 10	6	Graded assignment	Optional
Modern Methods of Biodegradation in Aquatic Ecosystems	Laboratory classes: 40 Project work: 20 Lecture: 10	6	Graded assignment	Optional
Sum	375	30		

Semester 7

Course	Number of hours	ECTS points	Form of verification	Obligatory
Elective Student Internships		6	Pass	Obligatory group
The student chooses 1 subject				
Internship in sustainable reporting	Internship: 0	6	Pass	Optional
Internship in bioengineering of industrial processes	Internship: 0	6	Pass	Optional
Diploma Seminar	Seminar: 30	2	Graded assignment + exam	Obligatory
Final Project	Diploma Thesis: 0	15	Pass	Obligatory
Graduates on the Job Market	Tutorials: 30	2	Graded assignment	Obligatory
Initiatives for the Socioeconomic Environment	Project work: 30	2	Graded assignment	Obligatory
Elective Courses 10		3	Graded assignment	Obligatory group
Student wybiera 1 przedmiot				
Sustainable Reporting and ESG Practices - Design Laboratory	Laboratory classes: 45	3	Graded assignment	Optional
Sustainable Processes for Manufacturing Innovative Products - Design Laboratory	Laboratory classes: 45	3	Graded assignment	Optional
Sum	135	30		