Learning outcomes for direction: **Biomedical Engineering**
Faculty: **Biomedical Engineering**

Direction: **Biomedical Engineering** Level of studies: **first-cycle studies** Profile of studies: **full- time studies**	
symbol	**Content of the learning outcome**
Konwledge: knows and understands	
K1A_W01	issues in mathematical analysis, in particular: • differential and integral calculus of functions of one variable and its applications, • ordinary differential equations, • differential and integral calculus of functions of many variables and its applications, • partial differential equations,
K1A_W02	issues in the area of: • elements of logic, • elements of algebra and linear algebra, • analytical geometry in R2 and R3, • elements of discrete mathematics,
K1A_W03	issues in the area of: • calculus of probability, • mathematical statistics,
K1A_W04	issues in a physics, in particular: • basic issues on general principles of physics, physical quantities, fundamental interactions, • issues of material point and rigid body mechanics, oscillatory and wave motion, fundamentals of thermodynamics, electricity, magnetism, optics, quantum physics,
K1A_W05	issues related to the principles of conducting and processing the results of physical measurements, types of measurement uncertainty and methods of their determination,
K1A_W06	the basic method of forming the structure and a set of functional properties of engineering and biomedical materials, choice of materials, research and related technology taking into consideration the application of the products,
K1A_W07	the most recent design solutions for medical devices, as well as their biomechanical and material issues,

K1A_W08	legal regulations concerning the rules of placing on the market and safety of using medical devices
K1A_W09	processes related to the functioning of various systems and organs and biochemical processes occurring in living organisms
K1A_W10	basics of modelling, musculoskeletal system, analysis of musculoskeletal system loads and distribution of strains and stresses in elements of the implant-bone system
K1A_W11	basics in the field of body mechanics, material strength and elementary issues necessary to understand statics, kinematics, dynamics
K1A_W12	basic issues concerning digital systems, in particular computer and microprocessor systems as well as designing and programming of such systems, the way of data representation and the elements included in the composition of the digital systems
K1A_W13	elementary issues of programming methodology and techniques, construction and analysis of algorithms as well as data structures and databases

K1A_W14	basic issues within physics and electrical engineering, basic laws connected with electrical current flow in electronic circuits, terms related to analysis of AC circuits allowing understanding the electronics issues.
K1A_W15	structure and functions of basic analogue and digital circuits, typical electronic components of such circuits, including analogue to digital converters, biomedical sensors and biosensors
K1A_W16	issues of signal theory (in one- and multidimensional space), including biomedical signals, methods of their acquisition and processing, pattern recognition as well as the analysis of such signals in different domains
K1A_W17	basics of automatics, control theory and control systems modelling, as well as methods of measurement and extraction of basic electrical and nonelectrical quantities, computational methods and informatics tools needed to analyse experiments results
K1A_W18	current state and the latest development trends in biomedical engineering
K1A_W19	basic issues necessary for understanding social, economical, legal and non- technical conditions of engineering activities and basic industrial safety regulations in biomedical engineering.
K1A_W20	issues related to the intellectual property protection and patents laws.
K1A_W21	concepts connected with physical chemistry, thermodynamics, electrochemistry, phase balance, chemical kinetics, phenomena on the phases border.
K1A_W22	basic issues of organic chemistry, the structure of natural and synthetic organic compounds, metabolic pathways and their regulation.

K1A_W23	issues related to the construction methods of implantation of artificial organs and implants including the immunological problems associated with their use
K1A_W24	ways of using software useful in designing, supporting calculations, as well as creating presentations and basics of service as well as the idea of using such software
K1A_W25	issues in the field of designing medical devices, and preparation of technical documentation.
K1A_W26	typical engineering technologies in the field of Biomedical Engineering

	Skills: is able
K1A_U01	to use rules of rigorous, logical thinking in the analysis of physical and technical processes,

K1A_U02	to use known mathematical apparatus to describe and analyze basic physical and technical problems, in particular: • to perform calculations in vector spaces and apply matrix calculus, • to use differential and integral calculus in solving problems of physics and technical sciences, • to use differential calculus for approximate calculations • to solve basic types of differential equations describing physical and technical phenomena, • to use methods of discrete mathematics for description and analysis of methods of discrete mathematics for description and analysis of finite objects occurring in physical and technical problems,
K1A_U03	to apply knowledge of calculus of probability and mathematical statistics to analyze experimental data, in particular: • to calculate probabilities in event spaces, determine distribution parameters of a random variable, use typical distributions of a random variable, • to prepare statistical data and use basic methods of statistical inference,
K1A_U04	to use the known principles and methods of physics and appropriate mathematical tools to solve typical tasks in mechanics, thermodynamics, electricity, magnetism, optics, quantum physics
K1A_U05	to perform basic physical measurements and process and present their results, in particular: • to construct a simple measurement system using standard • to measure devices, according to a given scheme and specification, • to determine the results and uncertainties of direct and indirect measurements, • evaluate the reliability of measurement results and interpret them in the context of their physical knowledge.

K1A_U06	to designing rehabilitation and medical equipment as well as the structure form of the implant, and also carry out their strength analysis
K1A_U07	to solve tasks in the field of general mechanics, material strength and multibody dynamics
K1A_U08	to formulate simple biomechanical models and use selected issues of strength of materials

K1A_U09	to select the appropriate material for a specific medical device and apply appropriate heat treatment
K1A_U10	to choose the appropriate test method to determine the mechanical properties of the analyzed material.
K1A_U11	to use CAD programs to develop projects, develop executive documentation and on this basis, the technological process framework of the analyzed form of a medical device.
K1A_U12	to select the appropriate method of measuring various physical quantities describing the organism, their interpretation and the range of variation.
K1A_U13	to classify and qualify medical devices and assess the compliance of medical devices with the essential requirements.
K1A_U14	to plan and conduct simple experiments, use basic methods and measurement tools, and the properties of biological sensors and sensors to measure electrical and non-electrical quantities in solving engineering tasks
K1A_U15	to acquire information from literature, data bases and other sources; integrate gathered information, interpret them with the aid of mathematical and statistical tools, as well as conclude, formulate and justify final opinions.
K1A_U16	to use the known methods and mathematical models, as well as computer simulations to analyze and evaluate the operation of systems and processes relevant in the discipline of Biomedical Engineering
K1A_U17	to work autonomously and as a team, estimate the time required for given task realization and prepare the work schedule guaranteeing keeping the deadlines.
K1A_U18	to create documentation concerning engineering task realization and prepare text including evaluation of obtained results, as well as prepare and present research results obtained as an effect of engineering task realisation

K1A_U19	to use English on communicative level, as well as read and understand technical documentation.
K1A_U20	to notice the need for self-study, necessary for professional competences improvement.

K1A_U21	to perform the analysis of signals and simple data processing systems in time and frequency domain, by means of appropriate methods and tools.
K1A_U22	to use simple analytical and experimental methods (including computational experiments) to formulate and to solve engineering tasks.
K1A_U23	to choose and use appropriate informatics tools (i.a. simulators, computer-aided engineering design applications) for engineering task solving, formulate and design the algorithm, as well as implement the algorithm in at least one high or low level programming language.
K1A_U24	to draw an electronic scheme, assemble, run and test simple electronic system, especially as a module of medical equipment.

Social competences: is ready for

K1A_K01	continuous self development (Master's studies, PhD Studies, post-graduate studies, courses) - improvement of professional and social competences.
K1A_K02	responsible performance of professional activities, including following the ethical rules, honesty and respect for various cultures and opinions.
K1A_K03	taking responsibility for his/her own work, following the group work rules and taking responsibility for common executed tasks.
K1A_K04	thinking and acting in enterprising way
K1A_K05	the analysis of faulty system operations, which caused serious financial, social and health losses or even death.