Biomedical engineering, specialization Medical Informatics (1st degree)
Diploma examination topics 2025/2026

Block: *Medicine*

No	Related course	Topics
1	Anatomy for Biomedical Engineers	Physical and biological properties of bones. Sequence of events in one complete cardiac cycle. Functions of the liver and their significance. Five major cavities in the human body.
2	Propaedeutics of Medical Sciences	Difference between etiology and symptomatology in the context of disease. Main imaging modalities used to diagnose pathologies of the digestive tract. Main types of grafts used in transplantation and the differences between them. Difference between oncogenes and tumor suppressor genes.
3	Introduction to Biomedical Optics and Biophotonics	Laws of reflection and refraction (Snell's law). The concept of refractive index. Compound optical microscope (thin lens approximation)—process of image formation and quantitative analysis of image magnification. Application of luminescence in medical diagnostics. Application of wave optics in medical imaging and diagnosis.
4	Introduction to Physiology	Homeostasis—definition, mechanism of action, and examples. Action potential and graded potentials. Mechanism of the heart's blood-pumping function and regulation of blood pressure. Main processes involved in urine production.
5	Medical Imaging Techniques	Hybrid imaging systems in nuclear medicine—concepts and their benefits. Principles of medical imaging techniques using ionizing radiation. Fundamental principles of magnetic resonance imaging. The role of artificial intelligence in medical imaging.
6	Legal and Ethical Aspects in Biomedical Engineering	Software as a medical device. MDD vs MDR—differences in medical device market regulations. Declaration of conformity of medical devices.

Block: *Fundamentals of programming*

No	Related course	Topics
7	Introduction to Programmming	Overview of the Java platform architecture. Programming paradigms and styles. Common sorting algorithms, their logic and time complexity.
8	Introduction to Object-Oriented Programming	Fundamental concepts of object-oriented programming in Java. Exception handling in Java. Generic data structures and collections in Java. Principles and practices of unit testing.

Block: *Computer science*

No	Related course	Topics
9	Databases	Database systems—architecture, historical development, system generations, and classification. Relational data model and NoSQL models. Overview of database security measures and their application in healthcare systems.
10	Mobile Application Development	Description of the Android activity lifecycle and its significance in mobile application development. Key lifecycle methods and strategies for managing state and resources effectively. Asynchronous task handling in Android. Principles of designing effective and user-friendly interfaces in Android applications.
11	Network Technologies	Common network topologies, fundamental definitions, and the ISO/OSI reference model. Description of the TCP/IP model and key protocols associated with each layer. Design principles of computer networks. Common network security concerns and the strategies used to mitigate these issues. Modern web application development using React and Spring.
12	Software Engineering	Main phases of the software development life cycle. Fundamental characteristics of the waterfall and agile approaches and the key differences between them. The role and importance of version control systems in modern software development. The role of code review, unit testing, and acceptance testing in ensuring software quality.

No	Related course	Topics
13	Computer Science in Medicine	The role of mobile technologies (mHealth) in healthcare, their specific aplications and benefits. Artificial intelligence and machine learning in medical diagnostics—applications, their advantages and limitations. Applications of biomolecular modelling techniques in drug discovery.

Block: *Electronics*

No	Related course	Topics
14	Introduction to Medical Electronics 1	Components of linear and stationary electrical circuits: current-voltage characteristics of perfect and real elements. Basic relationships between currents and voltages in linear electrical systems. Description of the steady-state behaviour of linear systems on sinusoidal stimulation. Parameters used to describe the properties of passive elements. Step response of the integrating and differentiating RC circuits.
15	Introduction to Medical Electronics 2	Amplifiers, their models and parameters. Operational amplifier—its properties and basic applications. Instrumentation amplifier. Digital circuits—examples of combinational and sequential logic circuits. Semiconductor diodes, their properties and typical applications.
16	Microcontrollers	Functional elements of a typical microcontroller. Applications of microcontrollers in the construction of measurement, diagnostic, and therapeutic devices. Subroutines—call and return from the subroutine. A stack and its use.
17	Electromedical Instrumentation	Basic technical components for biopotential measurement (electrode, amplifier, filter). Measurement techniques for the circulatory system, auditory system, respiratory system, nervous system, and muscular system. Safety codes for electromedical equipment. Inductive coupling and capacitive coupling.
18	Measurement systems	Topologies used in measurement systems, their properties and examples of implementation using wired and wireless communication interfaces. Local communication with digital measurement transducers—characteristics and organization of transmission in I2C and SPI interfaces. Analog-to-digital processing in measurement systems, the most commonly used processing methods and their properties.

Block: *Signal and image processing*

No	Related course	Topics
19	Digital Signal Processing	Principles and practical aspects for setting the sampling frequency of a signal. Principles of digital filtering. FIR vs IIR filters. Spectral representation of signals. The role of amplitude and phase spectra. Are negative frequencies in a spectral representation of a signal real or just a mathematical formulation?
20	Computer Graphics	Render engine. Rasterization, raytracing, pathtracing—physical basis and differences. Image representation in raster and vector graphics, their advantages and disadvantages. DPI and image resolution. 3D computer graphics pipeline from modelling to animation—approaches and examples.

Block: *Modelling and numerical methods*

No	Related course	Topics
21	Numerical Methods	Sources of errors in numerical calculations. Numerical differentiation. Numerical integration.
22	Modelling of Biological Systems	Practical implementation of statistical models, using Monte Carlo methods, QSAR, Markov chains etc. as examples. Force fields in molecular dynamics simulations—what they are and what role they play; examples of well-known solvent models. Advantages and disadvantages of the *in silico* approach.
23	Time Series Analysis	Time series forecasting algorithms (exponential smoothing, SARIMAX, and ML regressors). Model selection and information criteria. Neural networks in time series forecasting.
24	Complex System	Percolation model and the percolation threshold. Physical and biological phenomena that can be described using the percolation model. Complex networks—definition, basic characteristics, and examples of biological complex networks. Representation and analysis of biological complex networks. Cellular automaton and its possible applications for describing real-world phenomena.

No	Related course	Topics
25	Statistical Methods in Bioengineering	Is testing normality/Gaussianity of data useful? How to determine whether a given correlation value is statistically significant? Example of a multilinear regression model that can be reduced.
26	Artificial Intelligence 1 and 2	Fundamental architectures of modern neural networks. Learning mechanisms and training processes. Data processing in machine learning. Key dimensionality reduction algorithms and clustering methods. Modern methods for explainability and uncertainty quantification. Evaluation of knowledge representation in AI: for a given biomedical problem, analyze the provided representation focusing on the type of simplification applied to the represented object, the assumptions made and their justification, the types of inference it supports, computational efficiency, and ease of communication.