Study plan

Name of study plan: Biomedical Technology

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Biomedical Technology
Type of study: Bachelor full-time
Required credits: 180
Elective courses credits: 0
Sum of credits in the plan: 180
Note on the plan:

Name of the block: Compulsory courses
Minimal number of credits of the block: 170
The role of the block: Z

Code of the group: F7ABB POV 20
Name of the group: Biomedical Technology compulsory course
Requirement credits in the group: In this group you have to gain 170 credits
Requirement courses in the group: In this group you have to complete 56 courses
Credits in the group: 170
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
F7ABBALP	**Algorithmic and Programming Theory** *Lenka Hanáková, Pavel Smrčka, Tomáš Veselý, Christiane Malá* ***Pavel Smrčka*** *Pavel Smrčka (Gar.)*	KZ	4	2P+2C	Z	z
F7ABBAF1	**Anatomy and Physiology I.** *Anastasiya Lahutsina, Ksenia Sedova* ***Ksenia Sedova*** *Ksenia Sedova (Gar.)*	Z,ZK	4	2P+1C+1L	Z	z
F7ABBAF2	**Anatomy and Physiology II.** *Anastasiya Lahutsina, Ksenia Sedova, Anastasia Sedova* ***Anastasiya Lahutsina*** *Ksenia Sedova (Gar.)*	Z,ZK	4	2P+1C+1L	L	z
F7ABBA3A	**English Language IIIA (part 1)** *Eva Motyčková* ***Eva Motyčková*** *Eva Motyčková (Gar.)*	KZ	2	2C	Z	z
F7ABBA3B	**English Language IIIB (part 2)** *Eva Motyčková* ***Eva Motyčková*** *Eva Motyčková (Gar.)*	KZ	2	2C	L	z
F7ABBBP	**Bachelor Thesis** *Jiří Hozman* ***Jiří Hozman*** *Jiří Hozman (Gar.)*	Z	6	8C	L	z
17ABOZP	**Occupational Safety and Health, Fire Protection and First Aid** *Petr Kudrna* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	Z	0	1P	Z	z
F7ABBBCH	**Biochemistry** *Martina Turchichová, Anna Ludvíková* ***Anna Ludvíková*** *Martina Turchichová (Gar.)*	Z,ZK	2	1P+1L	Z	z
F7ABBBLS	**Biological Signals** *Václava Piorecká, Marek Piorecký* ***Václava Piorecká*** *Václava Piorecká (Gar.)*	Z,ZK	4	2P+2L	L	z
F7ABBBLG	**Biology** *Veronika Vymětalová* ***Veronika Vymětalová*** *Veronika Vymětalová (Gar.)*	Z,ZK	4	2P+2L	Z	z
F7ABBBB	**Biomechanics and Biomaterials** *Matej Daniel, Petr Volf* ***Petr Volf*** *Matej Daniel (Gar.)*	Z,ZK	4	2P+2L	Z	z
F7ABBBOZP	**Safety Regulations and Standards in Electrical Engineering** *Petr Kudrna* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	Z	1	1P	Z	z
F7ABBCHM	**Chemistry** *Iveta Horáčková, Libor Holík* ***Iveta Horáčková***	Z,ZK	4	2P+1C+1L	L	z
F7ABBEM	**Electrical Measurements** *Jan Vrba, Roman Matějka* ***Jan Vrba*** *Jan Vrba (Gar.)*	Z,ZK	4	2P+2C	Z	z
F7ABBELF	**Electrophysiology** *Ksenia Sedova, Anastasia Sedova* ***Anastasia Sedova*** *Ksenia Sedova (Gar.)*	Z,ZK	2	1P+1L	Z	z
F7ABBEO	**Electronic Circuits** *Pavel Máša, Tomáš Dřížďal, Ondřej Fišer* ***Ondřej Fišer*** *Pavel Máša (Gar.)*	Z,ZK	4	2P+2C	Z	z

F7ABBEBI	**Ethics in Biomedical Engineering** *Václav Navrátil* ***Václav Navrátil*** *Martina Dingová Šliková (Gar.)*	ZK	2	2P	L	z
F7ABBESP	**Management of Health Care Technology** *Jiří Hozman* ***Jiří Hozman*** *Jiří Hozman (Gar.)*	Z,ZK	2	1P+1C	L	z
F7ABBFY1	**Physics I.** *Jan Mikšovský, Petr Písařík* ***Petr Písařík*** *Jan Mikšovský (Gar.)*	Z,ZK	4	2P+1C+1L	Z	z
F7ABBFY2	**Physics II.** *Jan Mikšovský* ***Petr Písařík*** *Jan Mikšovský (Gar.)*	Z,ZK	6	2P+2C+2L	L	z
F7ABBFCH	**Physical Chemistry** *Libor Holík, Karel Roubík* ***Karel Roubík*** *Karel Roubík (Gar.)*	Z,ZK	4	2P+1C+1L	Z	z
F7ABBHE	**Hygiene and Epidemiology** *Anastasia Sedova* ***Anastasia Sedova*** *Emil Pavlík (Gar.)*	ZK	1	1P	L	z
F7ABBISZ	**Information Systems in Health Care** *Zoltán Szabó, David Jirsa* ***Zoltán Szabó*** *Zoltán Szabó (Gar.)*	Z,ZK	4	2P+2C	Z	z
F7ABBITP	**Integral Calculus** *Jiří Neustupa, Tomáš Parkman, Lukáš Liebzeit* ***Tomáš Parkman*** *Tomáš Parkman (Gar.)*	Z,ZK	4	2P+2C	L	z
F7ABBKT	**Communication Technology** *Christiane Malá, Martin Vítězník, Karel Hána, Jan Mužík, Tomáš Funda* ***Karel Hána*** *Karel Hána (Gar.)*	Z,ZK	2	1P+1C	Z	z
F7ABBKZS	**Conventional Imaging Systems** *Jiří Hozman, Tomáš Dřížďal, Martin Rožánek, Martin Čapek* ***Jiří Hozman*** *Jiří Hozman (Gar.)*	Z,ZK	4	2P+1C+1L	L	z
F7ABBLT	**Clinical Laboratory Instrumentation** *Martina Turchichová* ***Martina Turchichová*** *Martina Turchichová (Gar.)*	Z,ZK	4	2P+2L	L	z
F7ABBLPZ1	**Medical Devices and Equipment I. (Diagnostic Devices)** *Petr Kudrna, Karel Roubík, Martin Rožánek* ***Petr Kudrna*** *Martin Rožánek (Gar.)*	Z,ZK	4	2P+2L	Z	z
F7ABBLPZ2	**Medical Devices and Equipment II. (Therapeutical Devices)** *Petr Kudrna, Václav Ort, Ladislav Bís* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	Z,ZK	2	1P+1L	L	z
F7ABBLAD	**Linear Algebra and Differential Calculus** *Jiří Neustupa, Tomáš Parkman, Petr Maršálek* ***Tomáš Parkman*** *Tomáš Parkman (Gar.)*	Z,ZK	6	2P+4C	Z	z
F7ABBMAZ	**Management and Admininistration in Health Care** *Václav Navrátil* ***Václav Navrátil*** *Václav Navrátil (Gar.)*	KZ	1	1P	Z	z
F7ABBMEC	**Mechanics** *Matej Daniel, Tomáš Goldmann* ***Matej Daniel*** *Matej Daniel (Gar.)*	Z,ZK	4	2P+2L	L	z
F7ABBMT	**Medical Terminology** *Václav Navrátil* ***Václav Navrátil*** *Václav Navrátil (Gar.)*	Z	1	1C	Z	z
F7ABBMVP	**Research Methodology** *Marek Novák, Jakub Ráfl* ***Jakub Ráfl*** *Jakub Ráfl (Gar.)*	KZ	2	1P+1C	Z	z
F7ABBMS	**Modelling and Simulation** *Václav Petrák* ***Václav Petrák*** *Václav Petrák (Gar.)*	Z,ZK	4	2P+2C	L	z
F7ABBNMP	**Project Proposal and Management** *Václav Bláha* ***Václav Bláha*** *Václav Bláha (Gar.)*	KZ	2	1P+1C	L	z
F7ABBOIZ	**Protection Against Ionizing Radiation** *Tomáš Veselský* ***Tomáš Veselský*** *Jana Hudzietzová (Gar.)*	ZK	2	2P	L	z
F7ABBPPS	**Patient and Device Simulators and Testers** *Petr Kudrna, Martin Rožánek, Lenka Horáková* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	Z,ZK	2	1P+1L	Z	z
F7ABBPPM1	**Programming in Matlab I.** *Christiane Malá* ***Radim Krupička*** *Christiane Malá (Gar.)*	KZ	1	1C	Z	z
F7ABBPPM2	**Programming in Matlab II.** *Christiane Malá* ***Radim Krupička*** *Radim Krupička (Gar.)*	KZ	2	2C	L	z
F7ABBPNK	**Design and Construction of Medical Devices/Practical Exercises** *Roman Matějka, Jana Matějková* ***Roman Matějka*** *Roman Matějka (Gar.)*	KZ	4	4L	Z	z
F7ABBPMS	**Probability and Mathematical Statistics** *Marek Piorecký, Jan Štrobl, Michaela Mrázková, Filip Černý* ***Michaela Mrázková*** *Marek Piorecký (Gar.)*	Z,ZK	4	2P+2C	Z	z
F7ABBPP	**First Aid** *Martin Staněk* ***Martin Staněk*** *Martin Staněk (Gar.)*	KZ	2	1P+1C	L	z
F7ABBPSL	**Psychology** *Olga Shivairová* ***Olga Shivairová*** *Olga Shivairová (Gar.)*	KZ	2	1P+1C	Z	z
F7ABBROP	**Guided Practical Training** *Petr Kudrna* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	Z	2	80XH	L	z
F7ABBSPR1	**Semestral Project I.** *Petr Kudrna* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	KZ	1	1C	L	z
F7ABBSPR2	**Semestral Project II.** *Petr Kudrna* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	KZ	4	4C	Z	z
F7ABBSBP	**Bachelor Thesis Seminar** *Jiří Hozman* ***Jiří Hozman*** *Jiří Hozman (Gar.)*	Z	1	1C	L	z
F7ABBSM	**Sensors in Medicine** *David Vrba, Tomáš Pokorný, Jan Rédr* ***David Vrba*** *David Vrba (Gar.)*	Z,ZK	4	2P+2L	L	z
F7ABBSEL	**Power Engineering** *Jiří Hozman, David Vrba, Ondřej Fišer, Marek Novák* ***David Vrba*** *David Vrba (Gar.)*	Z,ZK	5	2P+3L	L	z

F7ABBSPT	**Equipment for Anaesthesiology and Resuscitation** *Karel Roubík, Václav Ort, Jakub Ráfl, Šimon Walzel* ***Jakub Ráfl*** *Václav Ort (Gar.)*	Z,ZK	4	2P+2L	L	z
F7ABBTEL	**Theory of Electrical Engineering** *Pavel Máša, Tomáš Dřížďal, Marek Novák* ***Tomáš Dřížďal*** *Pavel Máša (Gar.)*	Z,ZK	4	2P+2C	L	z
F7ABBTZS	**Tomographical Imaging Systems** *Jiří Hozman, Tomáš Dřížďal, Martin Rožánek, Evgeniia Karnoub* ***Martin Rožánek*** *Jiří Hozman (Gar.)*	Z,ZK	4	2P+1C+1L	Z	z
F7ABBUSS	**Introduction to Signals and Systems** *Jan Kauler* ***Jan Kauler*** *Jan Kauler (Gar.)*	Z,ZK	4	2P+2C	Z	z
F7ABBZP	**Fundamentals of Pathology** *Richard Becke* ***Richard Becke*** *Richard Becke (Gar.)*	ZK	2	2P	L	z
F7ABBZLN	**Legislation in Health Care and Technical Standards** *Vojtěch Kamenský, Peter Kneppo* ***Vojtěch Kamenský*** *Peter Kneppo (Gar.)*	KZ	2	1P+1C	Z	z

Characteristics of the courses of this group of Study Plan: Code=F7ABB POV 20 Name=Biomedical Technology compulsory course

F7ABBALP	Algorithmic and Programming Theory	KZ	4

Algorithm, data structures. Identifiers, data types. assignment statement, conditional statement, cycles. Arithmetical and logical operations. Digital representation of numbers, numeration systems. Introduction to structured programming in C language - building and structure of simple programs, creating of the user functions, user input and output, file management, memory management. Practical overview of programming techniques and basic algorithms in C language. Recursive and iterative methods, measuring algorithm quality. Abstract data-types, data sorting and searching, implementation of basic numerical algorithms. Introduction to biomedical data processing - programmers view. Introduction to software engineering.

F7ABBAF1	Anatomy and Physiology I.	Z,ZK	4

Anatomy and physiology I covers functional aspects of particular organs and their systems.

F7ABBAF2	Anatomy and Physiology II.	Z,ZK	4

Anatomy and physiology II links to Anatomy and Physiology I. The subject covers functional aspects of particular organs and their systems.

F7ABBA3A	English Language IIIA (part 1)	KZ	2

The aim of the course is to increase students' language competence in academic English and professional vocabulary, along with common communication skills. Students should be able to work actively with academic text, understand and be able to use basic terminology and be aware of the different stylistic levels of English and the associated syntactic and lexical devices.

F7ABBA3B	English Language IIIB (part 2)	KZ	2

Teaching activities in the summer semester are project-based.

F7ABBBP	Bachelor Thesis	Z	6

Individual student projects at the end of bachelor studies. Topics are selected during the 5th term from a list. Bachelor thesis is defended at the end of the examination period. Bachelor thesis defence is a part of the state exam. Bachelor thesis can be written and defended either Czech or English. Students are supervised by a tutor during the above mentioned process.

17ABOZP	Occupational Safety and Health, Fire Protection and First Aid	Z	0
F7ABBBCH	Biochemistry	Z,ZK	2

Course participants will be introduced to the basics of Biochemistry. The course builds on the knowledge gained in general chemistry and extends this knowledge about the chemistry of living systems. The interpretation goes through the basic building structures of biological systems (amino acids, peptides, proteins, lipids, carbohydrates, nucleic acids), biological membranes and molecular genetics to the most important metabolic processes. Particular attention is paid to the aspects necessary for understanding the methods of work in the biochemical and clinical laboratory, which are part of the follow-up chemical discipline. The laboratories are focused on broadening the topics discussed in the lectures and their practical training, especially on the determination of biomolecules and the verification of their properties. Students should become familiar with the basic laboratory techniques of Biochemistry.

F7ABBBLS	Biological Signals	Z,ZK	4

The subject deals with origins and description of the most important electric and non-electric biological signals. The principles of generation, recording and basic properties are studied in all the signals. The studied signals involve native and evoked biosignals, including biological signals of the heart, brain, muscles, nervous system, auditory signals, visual system, signals from the gastro-intestinal system etc. Advanced methods of digital biosignal processing,spectrum analysis, modern methods of artificial intelligence, features extraction, automatic classification, graphic presentation of results. Adaptive segmentation, artificial neural networks for signal procesing.

F7ABBBLG	Biology	Z,ZK	4

Basic information about the cellular level of organisms - from acelullar through prokaryotic to eukaryotic. The viruses. Prokaryotic cells. Bacteria. Bacterial diseases and their control. Eukaryotic cells. Plant and animal cell structure and function. Structure and conformation of biopolymers (nucleid acids and proteins). The nucleus, plastids, mitochondria. Cytoplasm. Endomembrane system: endoplasmic reticulum, the Golgi apparatus, lysosomes, vacuoles. Semiautonomic organelles: mitochondria, sites of respiration and chloroplasts, sites of photosynthesis. The origin of eukaryotes: endosymbiotic hypothesis. Ribosomes. The cytoskeleton: microtubules, microfilaments. The cell cycle: mitotic (M) phase and interphase (G1, S and G2 phases). The division of cell nucleus - amitosis, mitosis, phases of mitosis, the mitotic spindle; meiosis. The cell division - cytokinesis. Cell differentiation. Cell death. Apoptosis and necrosis. Mendelian and modern genetics: structure, function and inheritance of genes. Includes the chemistry and structure of chromatin and chromosomes. Animal tissue histology. Animal cells and tissues. Human genetics. Chromosomal aberrations, genetic disorders and diseases. Genetic engineering. GMO organisms.

F7ABBBB	Biomechanics and Biomaterials	Z,ZK	4

The course is intended for all students who need to supplement their knowledge and have a general knowledge about biomechanics and its application in specific practical problems. The content is chosen to be sufficient to understand athe issues in related subjects, especially the subject of Mechanics and Robotics in Medicine. If the student does not choose the subject and has never had the opportunity to complete these basic knowledge, they will be exposed to the risk of misunderstanding the subsequent issues in related subjects, in which this is not taken into account the basic knowledge.

F7ABBBOZP	Safety Regulations and Standards in Electrical Engineering	Z	1

Basic safety regulations, training and examinations from the sections of the regulation No. 50/1978 Coll. and instructions concerning the laboratory experiments based on the electrical devices. Factors determining electrical shock injury. Symbols and labeling in electrotechnology - safety colors importance, safety geometrical shape importance, examples of the safety legends, examples of the safety tables, graphical signs on the electrical devices, letter conductor labeling, AC nominal voltages, maximum values of the available current, short circuit and overloading protection, safety of the electrical devices - safety classes, periodical inspection and check of the electrical devices and hand tools, important norms, first aid in cases of electrical shock. Relationship of the law and safety regulations. Risk analysis in the field of electrotechnology. Special qualification in electrotechnology - regulation No. 50/1978 Coll. Validity based on the electrotechnology qualification and directive "B". Lasers safety regulations.

F7ABBCHM	Chemistry	Z,ZK	4

Introduction to chemistry, categorization and properties of substances, chemical bonds, chemical reactions, elements in periodic table, organic chemistry fundamentals, natural substances, polymers, analytical methods - instrumental analysis, chemical calculations, chemical equations

F7ABBEM	Electrical Measurements	Z,ZK	4

Measuring of electric values, principles, using, and parameters. Analogue measuring converters. Electromechanical measuring devices. Current and potential measuring. Frequency and shift phase measuring. Electric work and electric power measuring: direct current, single-phase and three-phase current. Electrical resistance and impedance measuring. Magnetic measuring. Analogue scope. Digitalization, digital signal processing, signal reconstruction. Electronic measuring devices: multimeter, digital scope. Optoelectronic measuring device.

F7ABBELF	Electrophysiology	Z,ZK	2
Aim/objectives: to introduce students to the theory of electrical phenomena at the cell, organ and organism level, to the possibilities of measuring and using these manifestations. A sub-objective is to enable students to experimentally verify the knowledge. This course builds on Anatomy and Physiology I and II and requires a basic knowledge of the structure (anatomy) and function (physiology) of the following systems (excitable tissues): nervous, musculoskeletal, circulatory (especially the heart). The course deals with the problems of excitable tissues (nervous, The course deals with the physiology of nervous tissue, muscle and glandular tissue and provides knowledge of the physiology of electrical processes at different levels: cell, tissue, organ, organism.			
F7ABBEO	Electronic Circuits	Z,ZK	4
The course provides a basic orientation in the principles of electronic circuits used in electronic laboratory and medical devices. It provides a prerequisite for the skilled operation of analogue and digital instrumentation. technology. Course entry requirements: Successful completion of Theoretical Electrical Engineering. Exit Knowledge, Skills, Abilities and Competencies: Students will become familiar with functional electronic blocks that are used in the design of laboratory and medical instruments. The course will prepare them to competently assess the basic properties and parameters of electronic devices.			
F7ABBEBI	Ethics in Biomedical Engineering	ZK	2
An overview of basic ethical concepts and theories in the context of applied ethics with respect to the professional orientation, maintenance, and development of humanities in technically oriented students. Prerequisites and co-requisites: Knowledge of humanities in the scope of secondary school studies (basics of philosophy, history, psychology). Acquired knowledge, skills, abilities, and competencies: Knowledge of basic concepts and controversial topics in theoretical and applied ethics, the ability to critically think, discuss, argue and defend their own views in ethical dilemma situations, developing the ability to work with literature, enhance empathy skills.			
F7ABBESP	Management of Health Care Technology	Z,ZK	2
F7ABBFY1	Physics I.	Z,ZK	4
Course Physics 1 is used to repeat and expand the basic knowledge of physics in the field of classical mechanics, thermals and optics, which is needed for further study at FBME CTU. Students will gain theoretical knowledge, the ability to solve numerical problems and practical skills associated with working in laboratories.			
F7ABBFY2	Physics II.	Z,ZK	6
The course Physics 2 follows the course Physics 1 and expands the acquired knowledge in the field of electromagnetism and the basics of atomic and nuclear physics and condensed matter physics.			
F7ABBFCH	Physical Chemistry	Z,ZK	4
Physical and chemical properties of substances. Basic calculations. Principles and behavior of systems of gases and liquids. Chemical bonds. Properties of solvents. Electrolytes. Dissociation of substances. Phase equilibria, multiface systems. Behavior and properties of vapors, evaporation. Electrochemical potential, electrodes. Electrodes of first and second kind. Referent and indication electrodes, electrodes for EKG, EEG, EMG etc. Redox potential. Inert electrodes. Membranes - types, properties and applications. Osmotic pressure. Ion selective electrodes. Acidity and basicity of solutions, pH. pH measurement. Stability of materials, corrosion. Passivation and self-passivation. Electrolysis and conductivity of solutions and its measurements. Polarography. Further methods of analysis of gases and solutions in BME (Biomedical Engineering.) Optical absorption. Spectrophotometry. Fluorescence and phosphorescence. Sensors for measuring of pH, pO2, pCO2, and SaO2 working on the basis of fibre optic cables and absorption or fluorescence. Advanced analytical devices. Mass spectroscopy, nuclear magnetic resonance, flame spectroscopy. Thermodynamics of reaction systems, basic calculations.			
F7ABBHE	Hygiene and Epidemiology	ZK	1
Students should learn theoretical basics of Epidemiology and Hygiene disciplines in depth covered by lecture topics. As result of this subject, student should be familiar with targets and working methods used in all disciplines of infectious and non-infectious epidemiology, environmental epidemiology and in solving of priorities and problems of Public Health Protection. Outcoming knowledge, skills, abilities and competences: Knowledge of basic methods used in preventive medical disciplines and legislation.			
F7ABBISZ	Information Systems in Health Care	Z,ZK	4
Lectures are oriented on medical informatics definition and basic characteristic of the different specialized areas. The relations between IS and health care structure, financing and controlling are analyzed as well. Some basic information technology, HW and SW tools are described in relation to IS design. A special attention is paid to medical data coding and interpretation, data and communication standards. Different types and features of clinical and hospital IS, decision support systems and regional health care IS are analyzed and discussed. Methodology of IS development, implementation and support are presented as well.			
F7ABBITP	Integral Calculus	Z,ZK	4
The subject is an introduction to integral calculus and integral transforms. Integral calculus: anti-derivative, indefinite integral, properties and methods of integration (integration by parts and by substitution, partial fractions), definite integral, properties, Newton-Leibnitz fundamental theorem, simple applications of both indefinite and definite integrals, improper integral, solving differential equations (ODEs) (1st order ODEs with separable variables, linear 1st order homogenous as well as non-homogenous ODEs, 2nd order linear homogenous and non-homogenous ODEs with constant coefficients),intro to multiple integrals, particularly double integral and applications. Integral transforms: Laplace transform and inverse Laplace transform and their application for solving nth order linear ODEs with constant coefficients.			
F7ABBKT	Communication Technology	Z,ZK	2
The aim of the course is to teach the student to understand the basic principles of the function of personal computers, their peripherals and communication interfaces. They will be able to configure the network interface and configure and connect a peripheral type of a standard medical devices equipped with a wired or wireless interface.			
F7ABBKZS	Conventional Imaging Systems	Z,ZK	4
Electromagnetic radiation spectrum and relationship to the modalities of medical diagnostic imaging systems. Fundamentals of imaging theory. Application of 2D FT. Transmission properties of imaging systems. Optical imaging systems including microscopic. Television imaging systems (including video endoscopic imaging systems). Basic digital image pre-processing methods. Infrared imaging systems (thermal imaging/IR imaging systems). X-ray imaging systems. Gamma imaging systems. Lectures and especially the laboratory exercises provide students with an overview of the principles of image formation in medicine for conventional imaging systems and methods. There are described methods for image data sensing, digitization and subsequent processing and principles of function and properties of sensing image devices in context, which is especially relevant from the interdisciplinary point of view of the whole course and study specialization. Knowledge, skills and competences: The student is able to explain the basic physical principle of the given modalities and knows its layout including the principle of image formation. The student is able to assess, on the basis of standard definition of technical parameters that imaging system meets the physician requirements for selected modality. Such knowledge is a prerequisite to the correct process technology selection and application of the modalities as well as the minimum necessary to ensure the required quality of the resulting image data.			
F7ABBLT	Clinical Laboratory Instrumentation	Z,ZK	4
Clinical laboratory instrumentation introduces principles of bioanalytical methods used in clinical diagnostics. Emphasis is put on optical methods (UV-VIS spectrophotometry, IR spectroscopy, AAS, AES, fluorimetry), NMR and X-ray analysis, electrochemical and electromigration methods (ion electrodes, biosensors, electrophoresis, isoelectric focusing), imunoassays and genetic methods (ELISA, PCR) as well as on chromatography and mass spectrometry. Contribution of lab automation to clinical diagnostics will be also discussed. During the laboratory course students will be introduced into the basics of work in bioanalytical laboratory and lab data processing.			
F7ABBLPZ1	Medical Devices and Equipment I. (Diagnostic Devices)	Z,ZK	4
Medical devices categories. Electrical safety of medical devices. Biopotentials amplifiers. Electrocardiographs, electromyographs and electroencephalographs. Dilution methods of blood flow and cardiac output measurement. Blood pressure measurement. Cardiac frequency measurement. Phonocardiography. Pulse oximetry. Medical monitors. Electrostimulation and electrosurgery medical devices. Therapeutic medical devices. Implantable medical devices. Telemetry. Medical devices for audiology.			
F7ABBLPZ2	Medical Devices and Equipment II. (Therapeutical Devices)	Z,ZK	2
Medical devices categories. The electrical safety of therapeutical medical devices. Artificial ventilation, introduction. Conventional ventilation. High-frequency ventilation. Extracorporeal membrane oxygenation. Hemodialysis. Drug infusion pumps (volumetric, syringe). Artificial cardiac pacemaker. Defibrillators (external, implantable). Cochlear implant. Electrosurgery units. Therapeutic ultrasound. Electro-therapy. Magneto-therapy.			

F7ABBLAD	Linear Algebra and Differential Calculus	Z,ZK	6
The course is introduction to differential calculus and linear algebra. Differential calculus - sets of numbers, sequences of real numbers, real functions (function properties, limits, continuity and derivative of a function investigation of function behavior), Taylor's formula, real number series. Linear algebra - vector spaces, matrices and determinants, systems of linear algebraic equations (solvability and solution), eigenvalues and eigenvectors of matrices, applications.			
F7ABBMAZ	Management and Admininistration in Health Care	KZ	1
Getting to know the structure of the health sector and financing models Health. Zoom administrative management issues various types of medical workplaces, their necessary interconnection. Orientation in the specific features of health facilities and European systems of health care workplaces.			
F7ABBMEC	Mechanics	Z,ZK	4
Students will get acquainted with the following areas of mechanics: General physical equations, Newton's laws, statics and dynamics. Force and moment effect - decomposition, replacement. Equilibrium of a force system in a plane and space - equation of equilibrium, systems into equilibrium. Reactions on statically determined systems - motion restrictions, spatial and planar constraints, solution of reactions. Static moment, center of gravity and center of area. Spatial moment of inertia - kinetic energy of rotational motion, product moment, momentum, law of conservation of momentum. Second moment of area - product moment, polar moment, Mohr circle, main moments of inertia, ellipse of inertia. Internal static effects - beam, system of plates, course of internal static effects, kinematic method, statically indeterminate problems. Mechanical properties of materials - tests of mechanical properties, stresses and deformations, Hooke's law. Stress and strain - uniaxial and biaxial stress state, simple bending, bending curve, torsional stress, cross-section design, thin-walled cross-sections, combined stress, nonlinear models. Buckling strength - critical load, stability of members, calculation of cross section. Tests of hardness, adhesion, toughness, tribological.			
F7ABBMT	Medical Terminology	Z	1
Attendants are made acquainted with particular terms flowing from latin but also greek expressions during their lectures. Students are continuously informed about terms of whole diagnosis and therapeutical procedures. Education is combined with continuous knowlegde check up through the use of tests.			
F7ABBMVP	Research Methodology	KZ	2
The course introduces students to the basic methods of research work and the requirements for scientific communication. The course also introduces students to the principles of writing and presenting of bachelor's thesis.			
F7ABBMS	Modelling and Simulation	Z,ZK	4
Basic concepts. Aims and consequences of modeling and simulation. The methodology of modeling and simulation. Inverse problem. Proposal for a new, respectively. additional experiment. Compartmental models. Physiological models. Pharmacokinetics. Continuous and discrete models of population dynamics. Epidemiological models. Veneral disease models.			
F7ABBNMP	Project Proposal and Management	KZ	2
As part of the lectures, students will become familiar with topics such as project management (PM) according to IPMA, the certification process, project, program, portfolio, phases, and the project life cycle, as well as project initiation. They will learn about the feasibility study, project initiation, project identification document, and logical framework. Other topics include an introduction to project planning, scheduling, risk and risk analysis, project implementation, behavioral competencies in PM, project closure, and evaluation. Students will also gain practical insights from a hospital environment. During the exercises, students will master the following concepts and topics and develop relevant outputs: teamwork, feasibility study, identification document, logical framework, WBS (Work Breakdown Structure a hierarchical structure of tasks or activities), scheduling, risk analysis, project implementation, and a final test. As part of this course, students have the opportunity to obtain the IPMA Level D certification, which is intended for aspiring project managers, project coordinators, and team members. The certification is valid for five years.			
F7ABBOIZ	Protection Against Ionizing Radiation	ZK	2
The aim of the course is to give students an overview of the issues of protection against ionizing radiation and dosimetry in general and in a specialized medical workplace. Student will studied properties of basic types of ionizing radiation, sources of ionizing radiation, interaction of gamma radiation with matter, interaction of charged particles with matter, photon and electron beam passage through the matter, units used in dosimetry and radiation protection, operational units for working and environment monitoring, dose measurement, internal contamination, shielding of simple sources. Special attention is paid to the exposure control of workers, residents and patients. In course students will give invormation about legislative interpretation of dosage limits. Entry requirements of the course: Structure of matter, basic types of nuclear transformations. Properties of basic types of ionizing radiation, sources of ionizing radiation. Interaction of gamma radiation with matter, interaction of charged particles with matter, passage of photon and electron beams through matter. Detection of ionizing radiation. Output knowledge, skills, abilities and competences: Units used in dosimetry and radiation protection. Principles and goals of radiation protection. Basic principles of protection against external ionizing radiation and protection against internal contamination. Dose limitation system, ionizing radiation in legislation of Czech Republic. Ionizing radiation use in healthcare.			
F7ABBPPS	Patient and Device Simulators and Testers	Z,ZK	2
Patient and instrument simulators and testers. Basic principles of implementation, connections with other disciplines. Detailed description and implementation of a selected model of a subsystem. Design and implementation of patient and instrument simulator sub-blocks. Examples of circuit implementations of simulators and testers. Environment, scenario creation and other related procedures in manikin control, basic concepts and principles of anesthesiology. Other types of simulators and phantoms. Possibilities of use in clinical practice. Practical demonstration. Connection of the simulator with other medical equipment. Simulators and testers. Implementation of an established simulation scenario, scenario testing, creation of new scenarios. Collaboration between HPS and anaesthesia machine.			
F7ABBPPM1	Programming in Matlab I.	KZ	1
The aim of the course is to acquaint students with the Matlab environment and language. Students will learn how to create functions and scripts in Matlab language, they will learn about data structures and work with data and their vizualization. The course is followed by the course Programming in Matlab II.			
F7ABBPPM2	Programming in Matlab II.	KZ	2
During the course the students will consolidate and widen their previous knowledge with the Matlab environment, programming language and with basic toolboxes. The course requires Matlab basics from course Programming in Matlab I. The students will learn how to create functions and scripts in Matlab, how to manipulate and visualize data and how to work with the basic toolboxes. As well the students will learn to create basic user interfaces.			
F7ABBPNK	Design and Construction of Medical Devices/Practical Exercises	KZ	4
The aim of the practically oriented course is to acquaint students with the design process of the measuring part of the device, ie basic problem analysis, determination of functional blocks and their design, selection of suitable components and their values with emphasis on working with catalog sheets and application recommendations, preparation of electrical documentation and board design. printed circuit board, its mounting, soldering and revitalization. During the course, students will implement a functional device (mounting, soldering, recovery) electronic thermometer, which will consist of two functional units - analog part for temperature measurement and signal conditioning (equipped with THT components) and display element with diode bargraph (equipped with SMT components). For both products, students will implement the design of the diagram and PCB in the CAD environment EAGLE. In addition to the analog part of the device, an application for digitizing data from the analog device using NI-DAQ cards and a cheap solution with the help of Arduino will be implemented. The last part will be a service intervention in the device (monitor of vital functions) with emphasis on safe handling and measurement of test points.			
F7ABBPMS	Probability and Mathematical Statistics	Z,ZK	4
Objectives: to familiarize students with the basic principles of the theory of probability and mathematical statistics. Pre-requisites and entry requirements of the course: Knowledge of mathematics (linear algebra, differential and integral calculus) in the range of F7PBBLAD and F7PBBITP courses taught in the first year of study. Knowledge, skills, abilities and competencies: The student is acquainted with the probabilistic model, basic definitions of Kolmogorov theory of probability and inductive statistics. The student can apply these definitions to practical problems that arise in other areas of professional work and can explain them sufficiently (e.g. doctors). The student is familiar with the basic methods of inductive statistics and can choose a suitable method for standard statistical problems.			
F7ABBPP	First Aid	KZ	2
The course gives a brief overview of the main principles and procedures of providing emergency first aid with special attention to the procedures for failure of basic vital functions and life threatening situations. The subject also includes situations of mass casualty of victims in crisis situations and emergencies, including the phenomenon of CBRN.			

F7ABBPSL	Psychology	KZ	2

Development, methodology and methods of psychology. Mental activities and psychic processes, psychology of personality, objects of psychology and their formation and development. Modern psychology; its concept and theory, psychic processes and stages. Psychological interpretation of personality. Application of knowledge in medical situations. Relation between technicians and medical doctors, technicians and patients, technicians and nurses. Communication as a tool for good cooperation amongst people and an aid to interactions. Basic expression and communication skills. Use of elocution and gestures in personal expression. Verbal and nonverbal communication. Dialogue; types of dialogue, questions during dialogue. Model situations. Communication process as part of economics - components, tools and functions.

F7ABBROP	Guided Practical Training	Z	2

Familiarization of students with the organization and provision of professional internships at the clinical workplace. Provision of contractual documents for the implementation of the ROP (supervised professional practice). The ROP will then enable the acquired practical skills and habits to be applied in the key subjects of the 3rd year. The student thus has an overview of the current technical level of hospital equipment; an overview of the organization of the work of biomedical technicians and engineers; can apply legal requirements to ensure the safe operation of medical equipment. He can communicate with technicians, but also medical staff. He is able to work in a team.

F7ABBSPR1	Semestral Project I.	KZ	1

The topic of the semester project (SPR1) must be in the field of biomedical engineering and must be related to the study field of the same name Biomedical Technician. The topics are available for the relevant academic year in the database projects.fbmi.cvut.cz Note: It is not possible to implement economic-managerial topics, topics based mainly on the creation of research, clean programming, topics purely in the field of biology, etc. The application must always be part of the work in accordance with the focus of the field. The topic must always be related to technology (medical devices, or the scope of work of a Biomedical Technician in clinical practice)! Entries that do not fall into the above areas will not be approved.

F7ABBSPR2	Semestral Project II.	KZ	4

The main idea is to start work on a project which can be improved in time and finish as a Bachelor thesis. In the course will be discussed topic as basic communication and presentation skills, including teamwork and project management. Creation of presentations and written texts. Typography rules. Types, purpose and requirements of technical presentations and technical texts. Writing a commented bibliographic search. The student solves topic (project) from the selection of the PROJECTS database - http://projects.fbmi.cvut.cz During the term, there are dedicated 2 hours every week for work under teacher supervising.

F7ABBSBP	Bachelor Thesis Seminar	Z	1

Objective(s): The aim of the course is to accentuate the realized outcomes of the projects solved in the 4th, 5th and 6th semesters of the Biomedical Technology Bachelor's degree study program. The aim of the course is also to prepare students for the defense of their bachelor thesis infront of the final state examination committee. Course entrance requirements: Prerequisite F7PBBMVP Exit Knowledge, Skills, Abilities and Competencies: Students are fully aware of the requirements for the requirements of professional reports and communications, they are proficient in the orientation in the professional literature. The students are able to understand the literature and literature on a given topic, apply scientific research methods to specific assignments. They present their proposed solutions and results, are able to interpret the results.

F7ABBSM	Sensors in Medicine	Z,ZK	4

This subject provides information about basic electronic devices - sensors, describes their operation principle, basic circuit configuration and application. The stress is aid mainly on clarifying of basic principles and practical utilization. Integral part of this course is basic information about sensors of non-electric quantities and their read-out circuits eg. strain related sensors (force, pressure, torque, vibration, displacement, acceleration etc.) magnetic field sensors, temperature sensors, chemical sensors, optical sensors and biosensors. The stress is aid on miniaturization, integration

F7ABBSEL	Power Engineering	Z,ZK	5

Basics of power electronics, power supplies, including electrochemical sources, rectifiers, stabilizers, the most commonly used types of motors, basics of power distribution, types of electrical systems and connecting appliances with a focus on medical use. Emphasis is placed primarily on the physical nature of the problem and its understanding. knowledge will be verified on practical examples and in the laboratory.

F7ABBSPT	Equipment for Anaesthesiology and Resuscitation	Z,ZK	4

The main objective of the course is to introduce students to the basic equipment of intensive care units (ICU) and anesthesiology and resuscitation departments of hospitals. These are devices to support vital functions, especially lung ventilation, as well as patient monitors, anesthesia machines and their parts and other equipment. Another objective of the course is to integrate knowledge and skills of students from the fields of science (especially physics, chemistry and physiology) and engineering (modeling, circuit theory, pneumatic elements, etc.) in the analysis of clinical technology and in the design and implementation of functional technical systems.

F7ABBTEL	Theory of Electrical Engineering	Z,ZK	4

Electric current, DC and AC currents. Electrical curcuits including R, L, C. Power of electric current, thermal effect of electric current. Distribution of electrical energy. Connection of the electrical systems. Input resistance and impedance, idle voltage, inner resistance and impedance of the source, mutual loading of the source and electrical appliance, impedance matching. Properties of circuits in time and frequency domain. Transient action in DC circuits, frequency characteristics of the L/C circuit. Electrical current in semiconductor, type of the conductivity, creation of the semiconductor crossing, properties in the forward and reverse direction. Bipolar transistor - transistor effect, basic principle in elementary circuit. Unipolar transistor. Unipolar transistors with complementary vodivosti (CMOS). Electromagnetic effects (induction, magnetization, force effect). Electromagnetic wave, spreading, interference, electromagnetic compatibility. Soft and hard magnetic materials. Transformers construction and parameters. Magnetic recording and reproduction of signals. Electromotors principles.

F7ABBTZS	Tomographical Imaging Systems	Z,ZK	4

CT systems (basic principle, schematic arrangement system, basic physical principle, developmental generations, basic principles of reconstruction). Imaging systems magnetic resonance. PET and SPECT principle. Specialized imaging systems (hybride). Ultrasound imaging systems. Doppler systems. Subject and especially laboratory exercises provide students with an insight into the principles of creating image data used in medicine, the principle of methods their scanning, digitization and subsequent processing, on the principle of function and properties of scanning image means in context, which is important especially in terms of interdisciplinarity of the subject and the field as a whole.

F7ABBUSS	Introduction to Signals and Systems	Z,ZK	4

To introduce students to basics of theory of signals and systems. To explain main principles on applications from biology and medicine. To become acquainted with basic mutual relations in computer laboratories by means of MATLAB.

F7ABBZP	Fundamentals of Pathology	ZK	2

The main goal of the course is represented by continuous enlargement of anatomical, physiological and multi-disciplinary consequences in human health and disease. At the very beginning of the course the fundamentals of cell structure disorders and metabolic paths disturbances are provided to understand pathology of organ systems and complexity of disease origin and causes. The course provides a wide overview of morphological and functional conditions in pathology. The knowledge is then simply transformable to clinical and technical disciplines used in examination and health monitoring of the patients. The Course Requirements: The enrolment to the course is contingent on successful finishing of the course Anytomy and Physiology II. Release and Results: The students obtain basic outline of pathological processes in the human body. Their skills comprise definition of disease, comprehension and description of pathological changes in organs and body structure. The theoretical basis of the course is oriented to use in technical branches of biomedical engineering.

F7ABBZLN	Legislation in Health Care and Technical Standards	KZ	2

Aims / aims: The aim of the course Legislation in Health Care and Technical Standards is to teach students the basic requirements and regulatory obligations in healthcare, especially in the field of medical devices. During the course, students will learn the basics of legislation process, as well as regulation related to the medical devices, lso with legislative regulations in the field of clinical trials and the operation of medical devices. Furthermore, students will learn the legal context of providing health care. The aim is to acquaint students with the rights and obligations arising from current legislation relating to health care issues.The emphasis is not on memorizing of the text of legal regulations, but on acquainting students with the main points and ideas contained in the laws, regulations and standards of the Czech Republic and EU directives in the field of healthcare. Prerequisites and co-requisites: To successfully complete the course, students should know the basics of the principles of medical devices due to the practical application of legislation in this area. Output knowledge, skills, abilities and competences: After completing the course, the student should have a comprehensive overview of health legislation. He should be able to orientate himself in a given problem related to legislation without any problems and he should know where he can find individual details related to legal issues in health care.

Name of the block: Compulsory elective courses

Minimal number of credits of the block: 10
The role of the block: S

Code of the group: F7ABB PV 2S 20
Name of the group: Biomedical Technology compulsory optional course
Requirement credits in the group: In this group you have to gain at least 2 credits (at most 6)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 3)
Credits in the group: 2
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors, **authors** and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
F7ABBEZP	**Economics of Health Services**	KZ	2	1P+1C	L	S
F7ABBMAT	**Marketing of Medical Technology** *Petra Hospodková **Petra Hospodková** Petra Hospodková (Gar.)*	KZ	2	2P	L	S
F7ABBPPP	**Programming Tools** *Christiane Malá, Martin Vítězník **Christiane Malá***	KZ	2	2C	L	S

Characteristics of the courses of this group of Study Plan: Code=F7ABB PV 2S 20 Name=Biomedical Technology compulsory optional course

F7ABBEZP	Economics of Health Services	KZ	2
Basic category of health care facility economics (hospitals, public and private health care facility) as: facility effectiveness, costs and income, financial management in health care, health care marketing etc. Specifics of health care facilities. Integral view of functioning of health care companies view on health care "company". Development of knowledge and skills in the field of financial management tools.			
F7ABBMAT	Marketing of Medical Technology	KZ	2
Marketing fundamentals, products management, basic knowledge concerning export activities in the field of marketing and commercial health care technology. Practical cases are presented including health care technology companies from the Czech Republic. Discussion and analysis of the real products are included in the exercises.			
F7ABBPPP	Programming Tools	KZ	2
Introduction to software tools on MS Windows platform and GNU/Linux platform. Short introduction of several software tools (MS Word, Excel, LateX, Powerpoint) and programming languages (Python, R, Java, CSS, bash) .			

Code of the group: F7ABB PV 3S 20
Name of the group: Biomedical Technology compulsory optional course
Requirement credits in the group: In this group you have to gain at least 2 credits (at most 6)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 3)
Credits in the group: 2
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors, **authors** and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
F7ABBBFT	**Biophotonics** *Jan Mikšovský, Jan Remsa **Jan Remsa** Jan Mikšovský (Gar.)*	KZ	2	2P	Z	S
F7ABBFVP	**Multivariable Calculus** *Petr Maršálek **Petr Maršálek** Petr Maršálek (Gar.)*	KZ	2	1P+1C	Z	S
F7ABBMFJ	**Physical Phenomena Modeling in COMSOL MULTIPHYSICS** *David Vrba, Jan Vrba **David Vrba** David Vrba (Gar.)*	KZ	2	1P+1C	Z	S

Characteristics of the courses of this group of Study Plan: Code=F7ABB PV 3S 20 Name=Biomedical Technology compulsory optional course

F7ABBBFT	Biophotonics	KZ	2
Overview of principles and applications in the interdisciplinary sphere, connecting physics, optics and biology. Interaction of laser radiation with matter, interaction of radiation with tissue, biology basics, photobiology, bioimaging, basics of lasers, laser safety, optical biosensors, photodynamical therapy, optical manipulation with cells, nanotechnology for biophotonics, biomaterials for photonics.			
F7ABBFVP	Multivariable Calculus	KZ	2
F7ABBMFJ	Physical Phenomena Modeling in COMSOL MULTIPHYSICS	KZ	2
Numerical simulations are increasingly being used to develop new and optimize existing products and devices. Numerical simulations can greatly reduce the number of prototypes needed and thus significantly accelerate and reduce development costs. Another sector where numerical simulations are used is a sector where it is difficult to verify ongoing physical processes (eg, heating the biological tissue under electrodes for direct brain simulation). Last but not least, based on numerical simulations, we can plan treatment where, based on knowledge of material properties, we can define the amount of power delivered to the device (eg radiofrequency ablation in oncology or cardiac surgery). Computer modeling involves the creation of geometry, setting of material properties and boundary conditions and, last but not least, the choice of differential equations, the method of discretization of the computing area and the processing of results. The accuracy of the results obtained, the length of calculations and the computational power requirements are very dependent on the numerical model setting. The lectures cover the most common problems in electrical engineering, thermics, mechanics, chemistry, acoustics and fluid dynamics. The acquired knowledge will be tested by the students when designing individual parts of devices and devices.			

Code of the group: F7ABB PV 4S 24

Name of the group: Biomedical Technology compulsory optional course
Requirement credits in the group: In this group you have to gain at least 2 credits (at most 8)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 4)
Credits in the group: 2
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors, **authors** and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
F7ABBDIZ	**Detectors of Ionizing Radiation**	KZ	2	2P	L	S
F7ABBMDT	**Microwave Diagnostics and Therapy** *David Vrba, Jan Vrba **Jan Vrba** Jan Vrba (Gar.)*	KZ	2	1P+1L	L	S
F7ABBPTI	**Principles and Practice in Tissue Engineering** *Roman Matějka **Roman Matějka** Roman Matějka (Gar.)*	KZ	2	0P+2C	L	S
F7ABBSJ	**Scripting Languages** *Tomáš Krajča **Radim Krupička** Radim Krupička (Gar.)*	KZ	2	2C	L	S

Characteristics of the courses of this group of Study Plan: Code=F7ABB PV 4S 24 Name=Biomedical Technology compulsory optional course

F7ABBDIZ	Detectors of Ionizing Radiation	KZ	2

Types of gas filled detectors, DC mode of IC, pulse mode of IC, proportional counters, pulse shape of proportional counter, neutron detection and spectrometry by means of nuclear reactions, principle of Geiger-Mueller counters, corona counter, preliminary of the scintillation detectors, exploitation of organic (solid and/or liquid) scintillators, Cerenkov detector, semiconductor detectors, Li compensated Ge detectors and HPGe detectors as photon detector.

F7ABBMDT	Microwave Diagnostics and Therapy	KZ	2

Interaction of the EM field with biological tissues and its use in diagnostics and therapy. Numerical methods suitable for modeling these interactions. Basics of microwave imaging (MWI). Perspective application of microwave techniques in medical diagnostics: non-invasive monitoring of blood glucose concentration, microwave detection and classification of cerebral vascular events and early detection of breast cancer. Therapeutic systems and applicators for microwave and RF local and regional hyperthermia. Planning treatment. Design and testing of applicators.

F7ABBPTI	Principles and Practice in Tissue Engineering	KZ	2
F7ABBSJ	Scripting Languages	KZ	2

The aim of the course is to understand the topic of scripting languages and their applications, to understand their advantages and disadvantages and their complementarity with system languages. Students will become familiar with regular expressions and tools for word processing. The course focuses on the scripting languages within the Unix operating system and the scripting languages Python.

Code of the group: F7ABB PV 5S 20
Name of the group: Biomedical Technology compulsory optional course
Requirement credits in the group: In this group you have to gain at least 2 credits (at most 8)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 4)
Credits in the group: 2
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors, **authors** and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
F7ABBAZD	**Biomedical Data Analysis and Processing** ***Jan Kauler***	KZ	2	1P+1C	Z	S
F7ABBMTB	**Microprocessors in Biomedicine** *Lenka Hanáková, Pavel Smrčka, Karel Hána, Jan Broulím **Karel Hána** Pavel Smrčka (Gar.)*	KZ	2	1P+1L	Z	S
F7ABBTA	**Technical Audiology**	KZ	2	1P+1L	Z	S
F7ABBZOD	**Image Data Processing** *Zoltán Szabó **Zoltán Szabó** Zoltán Szabó (Gar.)*	KZ	2	1P+1C	Z	S

Characteristics of the courses of this group of Study Plan: Code=F7ABB PV 5S 20 Name=Biomedical Technology compulsory optional course

F7ABBAZD	Biomedical Data Analysis and Processing	KZ	2

Time series analysis, trends, mutual dependency, stationarity. Correlation function and covariance function. Algorithms of correlation function estimation. Impact of removing trends to autocorrelation function. Periodogram - relationship between corellogram and periodogram. Frequency spectrum, spectrum of random signals. Linear frequency filtering. AR, ARMA, and MA processes. Spectral analysis. FFT algorithm. Non-parametric methods of the frequency spectrum estimation. Positives and negatives of the specteal analysis. Repeated measurements and analysis of their properties. AR a ARMA model parameter identification. Prediction. Bivariance analysis of time series - cross-correlation and cross-covariance and their estimation. Bispectrum.

F7ABBMTB	Microprocessors in Biomedicine	KZ	2

The aim is to explain the principles and building blocks of a microprocessor system, the structure of a microprocessor, the connection of basic peripherals, the programming model of a microcomputer system in the form of a practically oriented explanation and demonstration tasks. Provide a basic overview of ATMega and ARM Cortex M architectures with practical examples of their programming with examples of use in biomedicine. Prerequisites and co-requisites: basic knowledge of digital technology and signal processing, basics of ISO C. Output knowledge, skills, abilities and competencies: The student is familiar with the selection and design of microprocessor system solutions for use in biomedicine. It manages the configuration and program control of these building blocks of the microprocessor system: digital inputs and outputs, A / D and D / A converters, serial and parallel communication, counters and timers, interrupt controller. Understands the basics of communication of microcomputers with the environment: interfaces for LCD displays, keyboards, RS232, Ethernet, WIFI, Bluetooth, XBee and mobile 3G / 4G communication, GPS / GLONAS localization.

F7ABBTA	Technical Audiology	KZ	2

The aim of the course is to give students a basic overview of audiology, i.e. basic knowledge of biology, medicine and technology in relation to normal and impaired hearing, and all this in an interrelated context with emphasis on technical aspects. Motivation to work in clinical practice in audiology is also an integral part of this goal. workplace. Course entry requirements: These requirements are expressed as prerequisites and a detailed breakdown of the requirements is as follows: - nervous system - organisation and function of the CNS, internal environment of the CNS (blood-brain barrier, cerebrospinal formation, transport and function), neuroglia, motor nervous system, spinal cord (structure, reflexes), - nervous system - motor system, brainstem (structure, reflexes), cerebellum (structure, reflexes), basal ganglia (structure, reflexes), cerebral cortex (structure, rexlexes), physiology of movement control, - sensory nervous system - receptors, skin sensation, movement and position perception, vision, hearing, taste, smell, pain, autonomic nervous system, brain stem, hypothalamus, peripheral compartments: sympathetic and parasympathetic, - waves, types of waves, successive waves, interference, standing waves, sound, - types of signals, basic signal operations, signal decomposition, - harmonic analysis, Fourier transform for continuous and discrete signals, DFT, FFT, - convolution, - technical and biological systems, systems and their description, linear and non-linear system, - external description of continuous and discrete linear system - differential/differential equations, transfer functions, frequency characteristics, distribution of zeros and poles, time characteristics, - coupling of systems, feedback loops, - Characteristics of basic biosignals EEG, ECG, EOG, EP, EMG, artefacts, origin, sources, diagnostic applications, frequency range and bands, - Biological data acquisition and preprocessing, basic computer conversion chain, A/D converters, problems signal sampling and quantization, Nyquist theorem, conversion errors, signal conditioning, aliasing, filtering, trends, sensing options. Output knowledge, skills, abilities and competences: Students will acquire a basic understanding of acoustics, measurement and diagnosis of auditory functions, including technical principles. instrumentation and software, and hearing aids and replacements. The students will be able to orient themselves. They will be able to learn about these issues, learn about other areas of medical instrumentation and methods used in clinical practice, as well as motivated and ready to enter the field of audiology upon graduation and to add to this knowledge and advanced skills within the framework of the so-called certified course, which, according to Act 96/2004 Coll., allows for the acquisition of the so-called "certificate of audiology". Special professional competence Technical audiologist after graduation, i.e. after obtaining the so-called professional competence Biomedical technician under the Act.

F7ABBZOD	Image Data Processing	KZ	2

Continuous image representation, linear 2D systems, 2D spectrum, Digital representation of images, Basic image characteristics: brightness, contrast, resolution, noise, look up tables, histogram, Discrete Fourier transform, discrete cosine transform, image enhancement, geometric operations, image filtering, morphological operations, image restoration, image segmentation, basic principles of image compression.

Code of the group: F7ABB PV 6S 20
Name of the group: Biomedical Technology compulsory optional course
Requirement credits in the group: In this group you have to gain at least 2 credits (at most 6)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 3)
Credits in the group: 2
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
F7ABBAZC	**Algorithms for Biosignals Processing in the C Language** ***Pavel Smrčka***	KZ	2	1P+1C	L	S
F7ABBEMP	**Electromagnetic Fields of Living Organisms** *Jan Vrba, Ondřej Fišer* ***Ondřej Fišer*** *Jan Vrba (Gar.)*	KZ	2	1P+1L	L	S
F7ABBRBL	**Robotics in Medicine**	KZ	2	1P+1C	L	S

Characteristics of the courses of this group of Study Plan: Code=F7ABB PV 6S 20 Name=Biomedical Technology compulsory optional course

F7ABBAZC	Algorithms for Biosignals Processing in the C Language	KZ	2

The principle and implementation of the most used algorithms for biosignal processing and their specific functional (and time and memory efficient) implementation in C and C ++ will be explained in the form of a practically oriented interpretation and demonstration tasks. Graduates will be acquainted with specific solutions to basic algorithmic problems in biosignal processing: with segmentation, analysis in the time and frequency domain, with the design of linear digital filters (FIR and IIR) and with the visualization of results. Prerequisites and co-requisites: basic knowledge of systems and signal processing, basics of ISO C. Output knowledge, skills, abilities and competences: The student is familiar with algorithms for preprocessing and intelligent segmentation of biological time series in C and C ++, eg: FFT algorithm, SFFT and wavelet transforms, algorithm for calculating autocorrelation and cross-correlation functions, convolution, etc. Can implement in C language the floating time window method for feature extraction and basic algorithms for the design and implementation of digital FIR and IIR filters. Understands and can implement in C language the basic ways of visualization of biological data and the results of their processing.

F7ABBEMP	Electromagnetic Fields of Living Organisms	KZ	2

Static and quasi-static electric and magnetic fields, electromagnetic fields. Electrical and magnetic properties of biological tissues. Electrical, magnetic and electromagnetic stimulation in medicine. Anatomical and physiological bases of bioelectromagnetism. Bioelectric sources and conductive environment. Integral relations of electrodynamics of bioelectric fields, electrodynamic aspects of mathematical modeling of electrocardiography and electroencephalography. Topographic concept of bioelectrical and biomagnetic measurements. Methods and techniques of measurement. Human-robotic limb replacement interface.

F7ABBRBL	Robotics in Medicine	KZ	2

List of courses of this pass:

Code	Name of the course	Completion	Credits
17ABOZP	Occupational Safety and Health, Fire Protection and First Aid	Z	0
F7ABBA3A	English Language IIIA (part 1)	KZ	2

The aim of the course is to increase students' language competence in academic English and professional vocabulary, along with common communication skills. Students should be able to work actively with academic text, understand and be able to use basic terminology and be aware of the different stylistic levels of English and the associated syntactic and lexical devices.

F7ABBA3B	English Language IIIB (part 2)	KZ	2
	Teaching activities in the summer semester are project-based.		
F7ABBAF1	Anatomy and Physiology I.	Z,ZK	4
	Anatomy and physiology I covers functional aspects of particular organs and their systems.		
F7ABBAF2	Anatomy and Physiology II.	Z,ZK	4
	Anatomy and physiology II links to Anatomy and Physiology I. The subject covers functional aspects of particular organs and their systems.		
F7ABBALP	Algorithmic and Programming Theory	KZ	4
	Algorithm, data structures. Identifiers, data types. assignment statement, conditional statement, cycles. Arithmetical and logical operations. Digital representation of numbers, numeration systems. Introduction to structured programming in C language - building and structure of simple programs, creating of the user functions, user input and output, file management, memory management. Practical overview of programming techniques and basic algorithms in C language. Recursive and iterative methods, measuring algorithm quality. Abstract data-types, data sorting and searching, implementation of basic numerical algorithms. Introduction to biomedical data processing - programmers view. Introduction to software engineering.		
F7ABBAZC	Algorithms for Biosignals Processing in the C Language	KZ	2
	The principle and implementation of the most used algorithms for biosignal processing and their specific functional (and time and memory efficient) implementation in C and C ++ will be explained in the form of a practically oriented interpretation and demonstration tasks. Graduates will be acquainted with specific solutions to basic algorithmic problems in biosignal processing: with segmentation, analysis in the time and frequency domain, with the design of linear digital filters (FIR and IIR) and with the visualization of results. Prerequisites and co-requisites: basic knowledge of systems and signal processing, basics of ISO C. Output knowledge, skills, abilities and competences: The student is familiar with algorithms for preprocessing and intelligent segmentation of biological time series in C and C ++, eg: FFT algorithm, SFFT and wavelet transforms, algorithm for calculating autocorrelation and cross-correlation functions, convolution, etc. Can implement in C language the floating time window method for feature extraction and basic algorithms for the design and implementation of digital FIR and IIR filters. Understands and can implement in C language the basic ways of visualization of biological data and the results of their processing.		
F7ABBAZD	Biomedical Data Analysis and Processing	KZ	2
	Time series analysis, trends, mutual dependency, stationarity. Correlation function and covariance function. Algorithms of correlation function estimation. Impact of removing trends to autocorrelation function. Periodogram - relationship between corellogram and periodogram. Frequency spectrum, spectrum of random signals. Linear frequency filtering. AR, ARMA, and MA processes. Spectral analysis. FFT algorithm. Non-parametric methods of the frequency spectrum estimation. Positives and negatives of the specteal analysis. Repeated measurements and analysis of their properties. AR a ARMA model parameter identification. Prediction. Bivariance analysis of time series - cross-correlation and cross-covariance and their estimation. Bispectrum.		
F7ABBBB	Biomechanics and Biomaterials	Z,ZK	4
	The course is intended for all students who need to supplement their knowledge and have a general knowledge about biomechanics and its application in specific practical problems. The content is chosen to be sufficient to understand athe issues in related subjects, especially the subject of Mechanics and Robotics in Medicine. If the student does not choose the subject and has never had the opportunity to complete these basic knowledge, they will be exposed to the risk of misunderstanding the subsequent issues in related subjects, in which this is not taken into account the basic knowledge.		
F7ABBBCH	Biochemistry	Z,ZK	2
	Course participants will be introduced to the basics of Biochemistry. The course builds on the knowledge gained in general chemistry and extends this knowledge about the chemistry of living systems. The interpretation goes through the basic building structures of biological systems (amino acids, peptides, proteins, lipids, carbohydrates, nucleic acids), biological membranes and molecular genetics to the most important metabolic processes. Particular attention is paid to the aspects necessary for understanding the methods of work in the biochemical and clinical laboratory, which are part of the follow-up chemical discipline. The laboratories are focused on broadening the topics discussed in the lectures and their practical training, especially on the determination of biomolecules and the verification of their properties. Students should become familiar with the basic laboratory techniques of Biochemistry.		
F7ABBBFT	Biophotonics	KZ	2
	Overview of principles and applications in the interdisciplinary sphere, connecting physics, optics and biology. Interaction of laser radiation with matter, interaction of radiation with tissue, biology basics, photobiology, bioimaging, basics of lasers, laser safety, optical biosensors, photodynamical therapy, optical manipulation with cells, nanotechnology for biophotonics, biomaterials for photonics.		
F7ABBBLG	Biology	Z,ZK	4
	Basic information about the cellular level of organisms - from acelullar through prokaryotic to eukaryotic. The viruses. Prokaryotic cells. Bacteria. Bacterial diseases and their control. Eukaryotic cells. Plant and animal cell structure and function. Structure and conformation of biopolymers (nucleid acids and proteins). The nucleus, plastids, mitochondria. Cytoplasm. Endomembrane system: endoplasmic reticulum, the Golgi apparatus, lysosomes, vacuoles. Semiautonomic organelles: mitochondria, sites of respiration and chloroplasts, sites of photosynthesis. The origin of eukaryotes: endosymbiotic hypothesis. Ribosomes. The cytoskeleton: microtubules, microfilaments. The cell cycle: mitotic (M) phase and interphase (G1, S and G2 phases). The division of cell nucleus - amitosis, mitosis, phases of mitosis, the mitotic spindle; meiosis. The cell division - cytokinesis. Cell differentiation. Cell death. Apoptosis and necrosis. Mendelian and modern genetics: structure, function and inheritance of genes. Includes the chemistry and structure of chromatin and chromosomes. Animal tissue histology. Animal cells and tissues. Human genetics. Chromosomal aberrations, genetic disorders and diseases. Genetic engineering. GMO organisms.		
F7ABBBLS	Biological Signals	Z,ZK	4
	The subject deals with origins and description of the most important electric and non-electric biological signals. The principles of generation, recording and basic properties are studied in all the signals. The studied signals involve native and evoked biosignals, including biological signals of the heart, brain, muscles, nervous system, auditory signals, visual system, signals from the gastro-intestinal system etc. Advanced methods of digital biosignal processing,spectrum analysis, modern methods of artificial intelligence, features extraction, automatic classification, graphic presentation of results. Adaptive segmentation, artificial neural networks for signal procesing.		
F7ABBBOZP	Safety Regulations and Standards in Electrical Engineering	Z	1
	Basic safety regulations, training and examinations from the sections of the regulation No. 50/1978 Coll. and instructions concerning the laboratory experiments based on the electrical devices. Factors determining electrical shock injury. Symbols and labeling in electrotechnology - safety colors importance, safety geometrical shape importance, examples of the safety legends, examples of the safety tables, graphical signs on the electrical devices, letter conductor labeling, AC nominal voltages, maximum values of the available current, short circuit and overloading protection, safety of the electrical devices - safety classes, periodical inspection and check of the electrical devices and hand tools, important norms, first aid in cases of electrical shock. Relationship of the law and safety regulations. Risk analysis in the field of electrotechnology. Special qualification in electrotechnology - regulation No. 50/1978 Coll. Validity based on the electrotechnology qualification and directive "B". Lasers safety regulations.		
F7ABBBP	Bachelor Thesis	Z	6
	Individual student projects at the end of bachelor studies. Topics are selected during the 5th term from a list. Bachelor thesis is defended at the end of the examination period. Bachelor thesis defence is a part of the state exam. Bachelor thesis can be written and defended either Czech or English. Students are supervised by a tutor during the above mentioned process.		
F7ABBCHM	Chemistry	Z,ZK	4
	Introduction to chemistry, categorization and properties of substances, chemical bonds, chemical reactions, elements in periodic table, organic chemistry fundamentals, natural substances, polymers, analytical methods - instrumental analysis, chemical calculations, chemical equations		
F7ABBDIZ	Detectors of Ionizing Radiation	KZ	2
	Types of gas filled detectors, DC mode of IC, pulse mode of IC, proportional counters, pulse shape of proportional counter, neutron detection and spectrometry by means of nuclear reactions, principle of Geiger-Mueller counters, corona counter, preliminary of the scintillation detectors, exploitation of organic (solid and/or liquid) scintillators, Cerenkov detector, semiconductor detectors, Li compensated Ge detectors and HPGe detectors as photon detector.		

F7ABBEBI	Ethics in Biomedical Engineering	ZK	2
An overview of basic ethical concepts and theories in the context of applied ethics with respect to the professional orientation, maintenance, and development of humanities in technically oriented students. Prerequisites and co-requisites: Knowledge of humanities in the scope of secondary school studies (basics of philosophy, history, psychology). Acquired knowledge, skills, abilities, and competencies: Knowledge of basic concepts and controversial topics in theoretical and applied ethics, the ability to critically think, discuss, argue and defend their own views in ethical dilemma situations, developing the ability to work with literature, enhance empathy skills.			
F7ABBELF	Electrophysiology	Z,ZK	2
Aim/objectives: to introduce students to the theory of electrical phenomena at the cell, organ and organism level, to the possibilities of measuring and using these manifestations. A sub-objective is to enable students to experimentally verify the knowledge. This course builds on Anatomy and Physiology I and II and requires a basic knowledge of the structure (anatomy) and function (physiology) of the following systems (excitable tissues): nervous, musculoskeletal, circulatory (especially the heart). The course deals with the problems of excitable tissues (nervous, The course deals with the physiology of nervous tissue, muscle and glandular tissue and provides knowledge of the physiology of electrical processes at different levels: cell, tissue, organ, organism.			
F7ABBEM	Electrical Measurements	Z,ZK	4
Measuring of electric values, principles, using, and parameters. Analogue measuring converters. Electromechanical measuring devices. Current and potential measuring. Frequency and shift phase measuring. Electric work and electric power measuring: direct current, single-phase and three-phase current. Electrical resistance and impedance measuring. Magnetic measuring. Analogue scope. Digitalization, digital signal processing, signal reconstruction. Electronic measuring devices: multimeter, digital scope. Optoelectronic measuring device.			
F7ABBEMP	Electromagnetic Fields of Living Organisms	KZ	2
Static and quasi-static electric and magnetic fields, electromagnetic fields. Electrical and magnetic properties of biological tissues. Electrical, magnetic and electromagnetic stimulation in medicine. Anatomical and physiological bases of bioelectromagnetism. Bioelectric sources and conductive environment. Integral relations of electrodynamics of bioelectric fields, electrodynamic aspects of mathematical modeling of electrocardiography and electroencephalography. Topographic concept of bioelectrical and biomagnetic measurements. Methods and techniques of measurement. Human-robotic limb replacement interface.			
F7ABBEO	Electronic Circuits	Z,ZK	4
The course provides a basic orientation in the principles of electronic circuits used in electronic laboratory and medical devices. It provides a prerequisite for the skilled operation of analogue and digital instrumentation. technology. Course entry requirements: Successful completion of Theoretical Electrical Engineering. Exit Knowledge, Skills, Abilities and Competencies: Students will become familiar with functional electronic blocks that are used in the design of laboratory and medical instruments. The course will prepare them to competently assess the basic properties and parameters of electronic devices.			
F7ABBESP	Management of Health Care Technology	Z,ZK	2
F7ABBEZP	Economics of Health Services	KZ	2
Basic category of health care facility economics (hospitals, public and private health care facility) as: facility effectiveness, costs and income, financial management in health care, health care marketing etc. Specifics of health care facilities. Integral view of functioning of health care companies view on health care "company". Development of knowledge and skills in the field of financial management tools.			
F7ABBFCH	Physical Chemistry	Z,ZK	4
Physical and chemical properties of substances. Basic calculations. Principles and behavior of systems of gases and liquids. Chemical bonds. Properties of solvents. Electrolytes. Dissociation of substances. Phase equilibria, multiface systems. Behavior and properties of vapors, evaporation. Electrochemical potential, electrodes. Electrodes of first and second kind. Referent and indication electrodes, electrodes for EKG, EEG, EMG etc. Redox potential. Inert electrodes. Membranes - types, properties and applications. Osmotic pressure. Ion selective electrodes. Acidity and basicity of solutions, pH. pH measurement. Stability of materials, corrosion. Passivation and self-passivation. Electrolysis and conductivity of solutions and its measurements. Polarography. Further methods of analysis of gases and solutions in BME (Biomedical Engineering.) Optical absorption. Spectrophotometry. Fluorescence and phosphorescence. Sensors for measuring of pH, pO2, pCO2, and SaO2 working on the basis of fibre optic cables and absorption or fluorescence. Advanced analytical devices. Mass spectroscopy, nuclear magnetic resonance, flame spectroscopy. Thermodynamics of reaction systems, basic calculations.			
F7ABBFVP	Multivariable Calculus	KZ	2
F7ABBFY1	Physics I.	Z,ZK	4
Course Physics 1 is used to repeat and expand the basic knowledge of physics in the field of classical mechanics, thermals and optics, which is needed for further study at FBME CTU. Students will gain theoretical knowledge, the ability to solve numerical problems and practical skills associated with working in laboratories.			
F7ABBFY2	Physics II.	Z,ZK	6
The course Physics 2 follows the course Physics 1 and expands the acquired knowledge in the field of electromagnetism and the basics of atomic and nuclear physics and condensed matter physics.			
F7ABBHE	Hygiene and Epidemiology	ZK	1
Students should learn theoretical basics of Epidemiology and Hygiene disciplines in depth covered by lecture topics. As result of this subject, student should be familiar with targets and working methods used in all disciplines of infectious and non-infectious epidemiology, environmental epidemiology and in solving of priorities and problems of Public Health Protection. Outcoming knowledge, skills, abilities and competences: Knowledge of basic methods used in preventive medical disciplines and legislation.			
F7ABBISZ	Information Systems in Health Care	Z,ZK	4
Lectures are oriented on medical informatics definition and basic characteristic of the different specialized areas. The relations between IS and health care structure, financing and controlling are analyzed as well. Some basic information technology, HW and SW tools are described in relation to IS design. A special attention is paid to medical data coding and interpretation, data and communication standards. Different types and features of clinical and hospital IS, decision support systems and regional health care IS are analyzed and discussed. Methodology of IS development, implementation and support are presented as well.			
F7ABBITP	Integral Calculus	Z,ZK	4
The subject is an introduction to integral calculus and integral transforms. Integral calculus: anti-derivative, indefinite integral, properties and methods of integration (integration by parts and by substitution, partial fractions), definite integral, properties, Newton-Leibnitz fundamental theorem, simple applications of both indefinite and definite integrals, improper integral, solving differential equations (ODEs) (1st order ODEs with separable variables, linear 1st order homogenous as well as non-homogenous ODEs, 2nd order linear homogenous and non-homogenous ODEs with constant coefficients),intro to multiple integrals, particularly double integral and applications. Integral transforms: Laplace transform and inverse Laplace transform and their application for solving nth order linear ODEs with constant coefficients.			
F7ABBKT	Communication Technology	Z,ZK	2
The aim of the course is to teach the student to understand the basic principles of the function of personal computers, their peripherals and communication interfaces. They will be able to configure the network interface and configure and connect a peripheral type of a standard medical devices equipped with a wired or wireless interface.			
F7ABBKZS	Conventional Imaging Systems	Z,ZK	4
Electromagnetic radiation spectrum and relationship to the modalities of medical diagnostic imaging systems. Fundamentals of imaging theory. Application of 2D FT. Transmission properties of imaging systems. Optical imaging systems including microscopic. Television imaging systems (including video endoscopic imaging systems). Basic digital image pre-processing methods. Infrared imaging systems (thermal imaging/IR imaging systems). X-ray imaging systems. Gamma imaging systems. Lectures and especially the laboratory exercises provide students with an overview of the principles of image formation in medicine for conventional imaging systems and methods. There are described methods for image data sensing, digitization and subsequent processing and principles of function and properties of sensing image devices in context, which is especially relevant from the interdisciplinary point of view of the whole course and study specialization. Knowledge, skills and competences: The student is able to explain the basic physical principle of the given modalities and knows its layout including the principle of image formation. The student is able to assess, on the basis of standard definition of technical parameters that imaging system meets the			

physician requirements for selected modality. Such knowledge is a prerequisite to the correct process technology selection and application of the modalities as well as the minimum necessary to ensure the required quality of the resulting image data.

F7ABBLAD	Linear Algebra and Differential Calculus	Z,ZK	6

The course is introduction to differential calculus and linear algebra. Differential calculus - sets of numbers, sequences of real numbers, real functions (function properties, limits, continuity and derivative of a function investigation of function behavior), Taylor's formula, real number series. Linear algebra - vector spaces, matrices and determinants, systems of linear algebraic equations (solvability and solution), eigenvalues and eigenvectors of matrices, applications.

F7ABBLPZ1	Medical Devices and Equipment I. (Diagnostic Devices)	Z,ZK	4

Medical devices categories. Electrical safety of medical devices. Biopotentials amplifiers. Electrocardiographs, electromyographs and electroencephalographs. Dilution methods of blood flow and cardiac output measurement. Blood pressure measurement. Cardiac frequency measurement. Phonocardiography. Pulse oximetry. Medical monitors. Electrostimulation and electrosurgery medical devices. Therapeutic medical devices. Implantable medical devices. Telemetry. Medical devices for audiology.

F7ABBLPZ2	Medical Devices and Equipment II. (Therapeutical Devices)	Z,ZK	2

Medical devices categories. The electrical safety of therapeutical medical devices. Artificial ventilation, introduction. Conventional ventilation. High-frequency ventilation. Extracorporeal membrane oxygenation. Hemodialysis. Drug infusion pumps (volumetric, syringe). Artificial cardiac pacemaker. Defibrillators (external, implantable). Cochlear implant. Electrosurgery units. Therapeutic ultrasound. Electro-therapy. Magneto-therapy.

F7ABBLT	Clinical Laboratory Instrumentation	Z,ZK	4

Clinical laboratory instrumentation introduces principles of bioanalytical methods used in clinical diagnostics. Emphasis is put on optical methods (UV-VIS spectrophotometry, IR spectroscopy, AAS, AES, fluorimetry), NMR and X-ray analysis, electrochemical and electromigration methods (ion electrodes, biosensors, electrophoresis, isoelectric focusing), imunoassays and genetic methods (ELISA, PCR) as well as on chromatography and mass spectrometry. Contribution of lab automation to clinical diagnostics will be also discussed. During the laboratory course students will be introduced into the basics of work in bioanalytical laboratory and lab data processing.

F7ABBMAT	Marketing of Medical Technology	KZ	2

Marketing fundamentals, products management, basic knowledge concerning export activities in the field of marketing and commercial health care technology. Practical cases are presented including health care technology companies from the Czech Republic. Discussion and analysis of the real products are included in the exercises.

F7ABBMAZ	Management and Admininistration in Health Care	KZ	1

Getting to know the structure of the health sector and financing models Health. Zoom administrative management issues various types of medical workplaces, their necessary interconnection. Orientation in the specific features of health facilities and European systems of health care workplaces.

F7ABBMDT	Microwave Diagnostics and Therapy	KZ	2

Interaction of the EM field with biological tissues and its use in diagnostics and therapy. Numerical methods suitable for modeling these interactions. Basics of microwave imaging (MWI). Perspective application of microwave techniques in medical diagnostics: non-invasive monitoring of blood glucose concentration, microwave detection and classification of cerebral vascular events and early detection of breast cancer. Therapeutic systems and applicators for microwave and RF local and regional hyperthermia. Planning treatment. Design and testing of applicators.

F7ABBMEC	Mechanics	Z,ZK	4

Students will get acquainted with the following areas of mechanics: General physical equations, Newton's laws, statics and dynamics. Force and moment effect - decomposition, replacement. Equilibrium of a force system in a plane and space - equation of equilibrium, systems into equilibrium. Reactions on statically determined systems - motion restrictions, spatial and planar constraints, solution of reactions. Static moment, center of gravity and center of area. Spatial moment of inertia - kinetic energy of rotational motion, product moment, momentum, law of conservation of momentum. Second moment of area - product moment, polar moment, Mohr circle, main moments of inertia, ellipse of inertia. Internal static effects - beam, system of plates, course of internal static effects, kinematic method, statically indeterminate problems. Mechanical properties of materials - tests of mechanical properties, stresses and deformations, Hooke's law. Stress and strain - uniaxial and biaxial stress state, simple bending, bending curve, torsional stress, cross-section design, thin-walled cross-sections, combined stress, nonlinear models. Buckling strength - critical load, stability of members, calculation of cross section. Tests of hardness, adhesion, toughness, tribological.

F7ABBMFJ	Physical Phenomena Modeling in COMSOL MULTIPHYSICS	KZ	2

Numerical simulations are increasingly being used to develop new and optimize existing products and devices. Numerical simulations can greatly reduce the number of prototypes needed and thus significantly accelerate and reduce development costs. Another sector where numerical simulations are used is a sector where it is difficult to verify ongoing physical processes (eg, heating the biological tissue under electrodes for direct brain simulation). Last but not least, based on numerical simulations, we can plan treatment where, based on knowledge of material properties, we can define the amount of power delivered to the device (eg radiofrequency ablation in oncology or cardiac surgery). Computer modeling involves the creation of geometry, setting of material properties and boundary conditions and, last but not least, the choice of differential equations, the method of discretization of the computing area and the processing of results. The accuracy of the results obtained, the length of calculations and the computational power requirements are very dependent on the numerical model setting. The lectures cover the most common problems in electrical engineering, thermics, mechanics, chemistry, acoustics and fluid dynamics. The acquired knowledge will be tested by the students when designing individual parts of devices and devices.

F7ABBMS	Modelling and Simulation	Z,ZK	4

Basic concepts. Aims and consequences of modeling and simulation. The methodology of modeling and simulation. Inverse problem. Proposal for a new, respectively. additional experiment. Compartmental models. Physiological models. Pharmacokinetics. Continuous and discrete models of population dynamics. Epidemiological models. Veneral disease models.

F7ABBMT	Medical Terminology	Z	1

Attendants are made acquainted with particular terms flowing from latin but also greek expressions during their lectures. Students are continuously informed about terms of whole diagnosis and therapeutical procedures. Education is combined with continuous knowlegde check up through the use of tests.

F7ABBMTB	Microprocessors in Biomedicine	KZ	2

The aim is to explain the principles and building blocks of a microprocessor system, the structure of a microprocessor, the connection of basic peripherals, the programming model of a microcomputer system in the form of a practically oriented explanation and demonstration tasks. Provide a basic overview of ATMega and ARM Cortex M architectures with practical examples of their programming with examples of use in biomedicine. Prerequisites and co-requisites: basic knowledge of digital technology and signal processing, basics of ISO C. Output knowledge, skills, abilities and competencies: The student is familiar with the selection and design of microprocessor system solutions for use in biomedicine. It manages the configuration and program control of these building blocks of the microprocessor system: digital inputs and outputs, A / D and D / A converters, serial and parallel communication, counters and timers, interrupt controller. Understands the basics of communication of microcomputers with the environment: interfaces for LCD displays, keyboards, RS232, Ethernet, WIFI, Bluetooth, XBee and mobile 3G / 4G communication, GPS / GLONAS localization.

F7ABBMVP	Research Methodology	KZ	2

The course introduces students to the basic methods of research work and the requirements for scientific communication. The course also introduces students to the principles of writing and presenting of bachelor's thesis.

F7ABBNMP	Project Proposal and Management	KZ	2

As part of the lectures, students will become familiar with topics such as project management (PM) according to IPMA, the certification process, project, program, portfolio, phases, and the project life cycle, as well as project initiation. They will learn about the feasibility study, project initiation, project identification document, and logical framework. Other topics include an introduction to project planning, scheduling, risk and risk analysis, project implementation, behavioral competencies in PM, project closure, and evaluation. Students will also gain practical insights from a hospital environment. During the exercises, students will master the following concepts and topics and develop relevant outputs: teamwork, feasibility study, identification document, logical framework, WBS (Work Breakdown Structure a hierarchical structure of tasks or activities), scheduling, risk analysis, project implementation, and a final test. As part of this course, students have the opportunity to obtain the IPMA Level D certification, which is intended for aspiring project managers, project coordinators, and team members. The certification is valid for five years.

F7ABBOIZ	Protection Against Ionizing Radiation	ZK	2
The aim of the course is to give students an overview of the issues of protection against ionizing radiation and dosimetry in general and in a specialized medical workplace. Student will studied properties of basic types of ionizing radiation, sources of ionizing radiation, interaction of gamma radiation with matter, interaction of charged particles with matter, photon and electron beam passage through the matter, units used in dosimetry and radiation protection, operational units for working and environment monitoring, dose measurement, internal contamination, shielding of simple sources. Special attention is paid to the exposure control of workers, residents and patients. In course students will give invormation about legislative interpretation of dosage limits. Entry requirements of the course: Structure of matter, basic types of nuclear transformations. Properties of basic types of ionizing radiation, sources of ionizing radiation. Interaction of gamma radiation with matter, interaction of charged particles with matter, passage of photon and electron beams through matter. Detection of ionizing radiation. Output knowledge, skills, abilities and competences: Units used in dosimetry and radiation protection. Principles and goals of radiation protection. Basic principles of protection against external ionizing radiation and protection against internal contamination. Dose limitation system, ionizing radiation in legislation of Czech Republic. Ionizing radiation use in healthcare.			
F7ABBPMS	Probability and Mathematical Statistics	Z,ZK	4
Objectives: to familiarize students with the basic principles of the theory of probability and mathematical statistics. Pre-requisites and entry requirements of the course: Knowledge of mathematics (linear algebra, differential and integral calculus) in the range of F7PBBLAD and F7PBBITP courses taught in the first year of study. Knowledge, skills, abilities and competencies: The student is acquainted with the probabilistic model, basic definitions of Kolmogorov theory of probability and inductive statistics. The student can apply these definitions to practical problems that arise in other areas of professional work and can explain them sufficiently (e.g. doctors). The student is familiar with the basic methods of inductive statistics and can choose a suitable method for standard statistical problems.			
F7ABBPNK	Design and Construction of Medical Devices/Practical Exercises	KZ	4
The aim of the practically oriented course is to acquaint students with the design process of the measuring part of the device, ie basic problem analysis, determination of functional blocks and their design, selection of suitable components and their values with emphasis on working with catalog sheets and application recommendations, preparation of electrical documentation and board design. printed circuit board, its mounting, soldering and revitalization. During the course, students will implement a functional device (mounting, soldering, recovery) electronic thermometer, which will consist of two functional units - analog part for temperature measurement and signal conditioning (equipped with THT components) and display element with diode bargraph (equipped with SMT components). For both products, students will implement the design of the diagram and PCB in the CAD environment EAGLE. In addition to the analog part of the device, an application for digitizing data from the analog device using NI-DAQ cards and a cheap solution with the help of Arduino will be implemented. The last part will be a service intervention in the device (monitor of vital functions) with emphasis on safe handling and measurement of test points.			
F7ABBPP	First Aid	KZ	2
The course gives a brief overview of the main principles and procedures of providing emergency first aid with special attention to the procedures for failure of basic vital functions and life threatening situations. The subject also includes situations of mass casualty of victims in crisis situations and emergencies, including the phenomenon of CBRN.			
F7ABBPPM1	Programming in Matlab I.	KZ	1
The aim of the course is to acquaint students with the Matlab environment and language. Students will learn how to create functions and scripts in Matlab language, they will learn about data structures and work with data and their vizualization. The course is followed by the course Programming in Matlab II.			
F7ABBPPM2	Programming in Matlab II.	KZ	2
During the course the students will consolidate and widen their previous knowledge with the Matlab environment, programming language and with basic toolboxes. The course requires Matlab basics from course Programming in Matlab I. The students will learn how to create functions and scripts in Matlab, how to manipulate and visualize data and how to work with the basic toolboxes. As well the students will learn to create basic user interfaces.			
F7ABBPPP	Programming Tools	KZ	2
Introduction to software tools on MS Windows platform and GNU/Linux platform. Short introduction of several software tools (MS Word, Excel, LateX, Powerpoint) and programming languages (Python, R, Java, CSS, bash) .			
F7ABBPPS	Patient and Device Simulators and Testers	Z,ZK	2
Patient and instrument simulators and testers. Basic principles of implementation, connections with other disciplines. Detailed description and implementation of a selected model of a subsystem. Design and implementation of patient and instrument simulator sub-blocks. Examples of circuit implementations of simulators and testers. Environment, scenario creation and other related procedures in manikin control, basic concepts and principles of anesthesiology. Other types of simulators and phantoms. Possibilities of use in clinical practice. Practical demonstration. Connection of the simulator with other medical equipment. Simulators and testers. Implementation of an established simulation scenario, scenario testing, creation of new scenarios. Collaboration between HPS and anaesthesia machine.			
F7ABBPSL	Psychology	KZ	2
Development, methodology and methods of psychology. Mental activities and psychic processes, psychology of personality, objects of psychology and their formation and development. Modern psychology; its concept and theory, psychic processes and stages. Psychological interpretation of personality. Application of knowledge in medical situations. Relation between technicians and medical doctors, technicians and patients, technicians and nurses. Communication as a tool for good cooperation amongst people and an aid to interactions. Basic expression and communication skills. Use of elocution and gestures in personal expression. Verbal and nonverbal communication. Dialogue; types of dialogue, questions during dialogue. Model situations. Communication process as part of economics - components, tools and functions.			
F7ABBPTI	Principles and Practice in Tissue Engineering	KZ	2
F7ABBRBL	Robotics in Medicine	KZ	2
F7ABBROP	Guided Practical Training	Z	2
Familiarization of students with the organization and provision of professional internships at the clinical workplace. Provision of contractual documents for the implementation of the ROP (supervised professional practice). The ROP will then enable the acquired practical skills and habits to be applied in the key subjects of the 3rd year. The student thus has an overview of the current technical level of hospital equipment; an overview of the organization of the work of biomedical technicians and engineers; can apply legal requirements to ensure the safe operation of medical equipment. He can communicate with technicians, but also medical staff. He is able to work in a team.			
F7ABBSBP	Bachelor Thesis Seminar	Z	1
Objective(s): The aim of the course is to accentuate the realized outcomes of the projects solved in the 4th, 5th and 6th semesters of the Biomedical Technology Bachelor's degree study program. The aim of the course is also to prepare students for the defense of their bachelor thesis infront of the final state examination committee. Course entrance requirements: Prerequisite F7PBBMVP Exit Knowledge, Skills, Abilities and Competencies: Students are fully aware of the requirements for the requirements of professional reports and communications, they are proficient in the orientation in the professional literature. The students are able to understand the literature and literature on a given topic, apply scientific research methods to specific assignments. They present their proposed solutions and results, are able to interpret the results.			
F7ABBSEL	Power Engineering	Z,ZK	5
Basics of power electronics, power supplies, including electrochemical sources, rectifiers, stabilizers, the most commonly used types of motors, basics of power distribution, types of electrical systems and connecting appliances with a focus on medical use. Emphasis is placed primarily on the physical nature of the problem and its understanding. knowledge will be verified on practical examples and in the laboratory.			
F7ABBSJ	Scripting Languages	KZ	2
The aim of the course is to understand the topic of scripting languages and their applications, to understand their advantages and disadvantages and their complementarity with system languages. Students will become familiar with regular expressions and tools for word processing. The course focuses on the scripting languages within the Unix operating system and the scripting languages Python.			

F7ABBSM	Sensors in Medicine	Z,ZK	4
This subject provides information about basic electronic devices - sensors, describes their operation principle, basic circuit configuration and application. The stress is aid mainly on clarifying of basic principles and practical utilization. Integral part of this course is basic information about sensors of non-electric quantities and their read-out circuits eg. strain related sensors (force, pressure, torque, vibration, displacement, acceleration etc.) magnetic field sensors, temperature sensors, chemical sensors, optical sensors and biosensors. The stress is aid on miniaturization, integration			
F7ABBSPR1	Semestral Project I.	KZ	1
The topic of the semester project (SPR1) must be in the field of biomedical engineering and must be related to the study field of the same name Biomedical Technician. The topics are available for the relevant academic year in the database projects.fbmi.cvut.cz Note: It is not possible to implement economic-managerial topics, topics based mainly on the creation of research, clean programming, topics purely in the field of biology, etc. The application must always be part of the work in accordance with the focus of the field. The topic must always be related to technology (medical devices, or the scope of work of a Biomedical Technician in clinical practice)! Entries that do not fall into the above areas will not be approved.			
F7ABBSPR2	Semestral Project II.	KZ	4
The main idea is to start work on a project which can be improved in time and finish as a Bachelor thesis. In the course will be discussed topic as basic communication and presentation skills, including teamwork and project management. Creation of presentations and written texts. Typography rules. Types, purpose and requirements of technical presentations and technical texts. Writing a commented bibliographic search. The student solves topic (project) from the selection of the PROJECTS database - http://projects.fbmi.cvut.cz During the term, there are dedicated 2 hours every week for work under teacher supervising.			
F7ABBSPT	Equipment for Anaesthesiology and Resuscitation	Z,ZK	4
The main objective of the course is to introduce students to the basic equipment of intensive care units (ICU) and anesthesiology and resuscitation departments of hospitals. These are devices to support vital functions, especially lung ventilation, as well as patient monitors, anesthesia machines and their parts and other equipment. Another objective of the course is to integrate knowledge and skills of students from the fields of science (especially physics, chemistry and physiology) and engineering (modeling, circuit theory, pneumatic elements, etc.) in the analysis of clinical technology and in the design and implementation of functional technical systems.			
F7ABBTA	Technical Audiology	KZ	2
The aim of the course is to give students a basic overview of audiology, i.e. basic knowledge of biology, medicine and technology in relation to normal and impaired hearing, and all this in an interrelated context with emphasis on technical aspects. Motivation to work in clinical practice in audiology is also an integral part of this goal. workplace. Course entry requirements: These requirements are expressed as prerequisites and a detailed breakdown of the requirements is as follows: - nervous system - organisation and function of the CNS, internal environment of the CNS (blood-brain barrier, cerebrospinal formation, transport and function), neuroglia, motor nervous system, spinal cord (structure, reflexes), - nervous system - motor system, brainstem (structure, reflexes), cerebellum (structure, reflexes), basal ganglia (structure, reflexes), cerebral cortex (structure, rexlexes), physiology of movement control, - sensory nervous system - receptors, skin sensation, movement and position perception, vision, hearing, taste, smell, pain, autonomic nervous system, brain stem, hypothalamus, peripheral compartments: sympathetic and parasympathetic, - waves, types of waves, successive waves, interference, standing waves, sound, - types of signals, basic signal operations, signal decomposition, - harmonic analysis, Fourier transform for continuous and discrete signals, DFT, FFT, - convolution, - technical and biological systems, systems and their description, linear and non-linear system, - external description of continuous and discrete linear system - differential/differential equations, transfer functions, frequency characteristics, distribution of zeros and poles, time characteristics, - coupling of systems, feedback loops, - Characteristics of basic biosignals EEG, ECG, EOG, EP, EMG, artefacts, origin, sources, diagnostic applications, frequency range and bands, - Biological data acquisition and preprocessing, basic computer conversion chain, A/D converters, problems signal sampling and quantization, Nyquist theorem, conversion errors, signal conditioning, aliasing, filtering, trends, sensing options. Output knowledge, skills, abilities and competences: Students will acquire a basic understanding of acoustics, measurement and diagnosis of auditory functions, including technical principles. instrumentation and software, and hearing aids and replacements. The students will be able to orient themselves. They will be able to learn about these issues, learn about other areas of medical instrumentation and methods used in clinical practice, as well as motivated and ready to enter the field of audiology upon graduation and to add to this knowledge and advanced skills within the framework of the so-called certified course, which, according to Act 96/2004 Coll., allows for the acquisition of the so-called "certificate of audiology". Special professional competence Technical audiologist after graduation, i.e. after obtaining the so-called professional competence Biomedical technician under the Act.			
F7ABBTEL	Theory of Electrical Engineering	Z,ZK	4
Electric current, DC and AC currents. Electrical curcuits including R, L, C. Power of electric current, thermal effect of electric current. Distribution of electrical energy. Connection of the electrical systems. Input resistance and impedance, idle voltage, inner resistance and impedance of the source, mutual loading of the source and electrical appliance, impedance matching. Properties of circuits in time and frequency domain. Transient action in DC circuits, frequency characteristics of the L/C circuit. Electrical current in semiconductor, type of the conductivity, creation of the semiconductor crossing, properties in the forward and reverse direction. Bipolar transistor - transistor effect, basic principle in elementary circuit. Unipolar transistor. Unipolar transistors with complementary vodivosti (CMOS). Electromagnetic effects (induction, magnetization, force effect). Electromagnetic wave, spreading, interference, electromagnetic compatibility. Soft and hard magnetic materials. Transformers construction and parameters. Magnetic recording and reproduction of signals. Electromotors principles.			
F7ABBTZS	Tomographical Imaging Systems	Z,ZK	4
CT systems (basic principle, schematic arrangement system, basic physical principle, developmental generations, basic principles of reconstruction). Imaging systems magnetic resonance. PET and SPECT principle. Specialized imaging systems (hybride). Ultrasound imaging systems. Doppler systems. Subject and especially laboratory exercises provide students with an insight into the principles of creating image data used in medicine, the principle of methods their scanning, digitization and subsequent processing, on the principle of function and properties of scanning image means in context, which is important especially in terms of interdisciplinarity of the subject and the field as a whole.			
F7ABBUSS	Introduction to Signals and Systems	Z,ZK	4
To introduce students to basics of theory of signals and systems. To explain main principles on applications from biology and medicine. To become acquainted with basic mutual relations in computer laboratories by means of MATLAB.			
F7ABBZLN	Legislation in Health Care and Technical Standards	KZ	2
Aims / aims: The aim of the course Legislation in Health Care and Technical Standards is to teach students the basic requirements and regulatory obligations in healthcare, especially in the field of medical devices. During the course, students will learn the basics of legislation process, as well as regulation related to the medical devices, lso with legislative regulations in the field of clinical trials and the operation of medical devices. Furthermore, students will learn the legal context of providing health care. The aim is to acquaint students with the rights and obligations arising from current legislation relating to health care issues.The emphasis is not on memorizing of the text of legal regulations, but on acquainting students with the main points and ideas contained in the laws, regulations and standards of the Czech Republic and EU directives in the field of healthcare. Prerequisites and co-requisites: To successfully complete the course, students should know the basics of the principles of medical devices due to the practical application of legislation in this area. Output knowledge, skills, abilities and competences: After completing the course, the student should have a comprehensive overview of health legislation. He should be able to orientate himself in a given problem related to legislation without any problems and he should know where he can find individual details related to legal issues in health care.			
F7ABBZOD	Image Data Processing	KZ	2
Continuous image representation, linear 2D systems, 2D spectrum, Digital representation of images, Basic image characteristics: brightness, contrast, resolution, noise, look up tables, histogram, Discrete Fourier transform, discrete cosine transform, image enhancement, geometric operations, image filtering, morphological operations, image restoration, image segmentation, basic principles of image compression.			
F7ABBZP	Fundamentals of Pathology	ZK	2
The main goal of the course is represented by continuous enlargement of anatomical, physiological and multi-disciplinary consequences in human health and disease. At the very beginning of the course the fundamentals of cell structure disorders and metabolic paths disturbances are provided to understand pathology of organ systems and complexity of disease origin and causes. The course provides a wide overview of morphological and functional conditions in pathology. The knowledge is then simply transformable to clinical and technical disciplines used in examination and health monitoring of the patients. The Course Requirements: The enrolment to the course is contingent on successful finishing of the course Anytomy			

and Physiology II. Release and Results: The students obtain basic outline of pathological processes in the human body. Their skills comprise definition of disease, comprehension and description of pathological changes in organs and body structure. The theoretical basis of the course is oriented to use in technical branches of biomedical engineering.

For updated information see http://bilakniha.cvut.cz/en/FF.html
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