Recomended pass through the study plan

Name of the pass: Biomedical Engineering - 20/21, 21/22, 22/23, 23/24, 24/25, 25/26

Faculty/Institute/Others:
Department:
Pass through the study plan: Biomedical Engineering
Branch of study guranteed by the department: Welcome page
Guarantor of the study branch:
Program of study: Biomedical Engineering
Type of study: Follow-up master full-time
Note on the pass: Informaci o předepsaném minimálním počtu PV předmětů pro konkrétní jednotlivé semestry najdete v odpovídajícím studijním plánu programu.

Coding of roles of courses and groups of courses:
P - compulsory courses of the program, PO - compulsory courses of the branch, Z - compulsory courses, S - compulsory elective courses, PV - compulsory elective courses, F - elective specialized courses, V - elective courses, T - physical training courses

Coding of ways of completion of courses (KZ/Z/ZK) and coding of semesters (Z/L):
KZ - graded assesment, Z - assesment, ZK - examination, L - summer semester, Z - winter semester

Number of semester: 1

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
F7PMBAM	**Applied Mathematics** *Karel Roubík, Martin Rožánek, Jiří Hozman, Ondřej Fišer **Ondřej Fišer** Karel Roubík (Gar.)*	KZ	4	2P+1C	Z	z
17BOZP	**Occupational Safety and Health, Fire Protection and First Aid** *Petr Kudrna **Petr Kudrna** Petr Kudrna (Gar.)*	Z	0	1P	Z	z
F7PMBBSC	**Biotransport** *Jana Matějková, Roman Matějka **Roman Matějka** Roman Matějka (Gar.)*	Z,ZK	5	2P+2L	Z	z
F7PMBCZS	**Digital Signal Processing** *Marek Piorecký, Jan Štrobl, Václava Piorecká **Václava Piorecká** Václava Piorecká (Gar.)*	Z,ZK	5	2P+2C	Z	z
F7PMBZAO	**Image Processing and Analysis** *Marek Piorecký, Jan Štrobl, Václav Hlaváč, Zoltán Szabó **Zoltán Szabó** Václav Hlaváč (Gar.)*	Z,ZK	5	2P+2C	Z	z
F7PMBOP1	**Internship I.** *Petr Kudrna **Petr Kudrna** Petr Kudrna (Gar.)*	Z	2	2 XT	Z	z
F7PMBPIZ	**Work with Information Sources and Research Methodology** *Karel Roubík, Jakub Ráfl, Šimon Walzel **Jakub Ráfl** Jakub Ráfl (Gar.)*	KZ	4	1P+2C	Z	z
F7PMBSPB	**Statistics for Biomedicine** *Marek Piorecký, Jan Štrobl, Jakub Ráfl, Marian Rybář, Aleš Tichopád **Jakub Ráfl** Aleš Tichopád (Gar.)*	Z,ZK	5	2P+2C	Z	z

Number of semester: 2

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
F7PMBDAE	**Product Design and Ergonomy in Health Care** ***Václava Piorecká***	Z	4	4C	L	z
F7PMBEMEO	**Electrotechnology and Modern Electronic Circuits** ***Jiří Hozman***	Z,ZK	5	2P+2L	L	z
F7PMBKB	**Clinical Biochemistry and Laboratory Diagnostic Methods**	Z,ZK	5	2P+2L	L	z
F7PMBMAR	**Measurements and Control in Biomedicine** ***Roman Matějka***	Z,ZK	5	2P+2L	L	z
F7PMBOP2	**Internship II.** ***Petr Kudrna***	Z	2	2XT	L	z
F7PMBPOD	**Entrepreneurship**	KZ	3	1P+1C	L	z
F7PMBPMZD	**Advanced Methods of Analysis and Data Processing** ***Václava Piorecká***	KZ	3	1P+1C	L	z
F7PMBRP	**Semester Project** ***Ondřej Fišer***	Z	3	2S	L	z

Number of semester: 3

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
F7PMBCZT	**Certification of Medical Technology** *Peter Kneppo, Ondřej Gajdoš, Vojtěch Kamenský* ***Vojtěch Kamenský*** *Peter Kneppo (Gar.)*	Z,ZK	3	1P+1C	Z	z
F7PMBDS1	**Diploma Thesis Seminar I.** *Martin Rožánek, Ondřej Fišer* ***Ondřej Fišer*** *Martin Rožánek (Gar.)*	Z	5	4S	Z	z
F7PMBMTB	**Fluid Mechanics in Biomedicine** *Karel Roubík, Šimon Walzel, Václav Ort* ***Karel Roubík*** *Karel Roubík (Gar.)*	Z,ZK	5	2P+1C+1L	Z	z
F7PMBOP3	**Internship III.** *Petr Kudrna* ***Petr Kudrna*** *Petr Kudrna (Gar.)*	Z	2	2XT	Z	z
F7PMBPPTD	**Advanced Medical Devices for Diagnostics** *Martin Rožánek, Petr Kudrna, Tomáš Dřížďal* ***Petr Kudrna*** *Martin Rožánek (Gar.)*	Z,ZK	4	2P+1C	Z	z
F7PMBSPMM	**Software for Mathematical Modeling** *Bartoloměj Biskup* ***Bartoloměj Biskup*** *Bartoloměj Biskup (Gar.)*	Z,ZK	5	2P+2C	Z	z
F7PMBVZ	**Public Health, Management of Medical Facilities** *Věra Adámková, Jan Bříza* ***Jan Bříza*** *Věra Adámková (Gar.)*	ZK	3	2P	Z	z
F7PMBZPO	**Introduction to Law and the Protection of Industrial Property** *Peter Kneppo, Vojtěch Kamenský, Václav Kratochvíl* ***Vojtěch Kamenský*** *Peter Kneppo (Gar.)*	ZK	3	2P	Z	z

Number of semester: 4

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
F7PMBDP	**Diploma Thesis** ***Martin Rožánek***	Z	12	80ZP	L	z
F7PMBDS2	**Diploma Thesis Seminar II.** ***Martin Rožánek***	Z	3	2S	L	z
F7PMBKST	**Quality, Reliability, Testing of Medical Devices** ***Vojtěch Kamenský***	ZK	3	2P+1C	L	z
F7PMBNPM	**Nanotechnology for Medicine**	Z,ZK	3	2P+1C	L	z
F7PMBPTT	**Advanced Medical Devices for Therapy** ***Petr Kudrna***	ZK	3	2P	L	z
F7PMBTVZ	**Technical Equipment for Health Care Facilities, the Infrastructure and Architecture**	ZK	3	2P	L	z
F7PMBZMO	**Medical Imaging Processing**	Z	3	2C	L	z

List of groups of courses of this pass with the complete content of members of individual groups

List of courses of this pass:

Code	Name of the course	Completion	Credits
17BOZP	Occupational Safety and Health, Fire Protection and First Aid	Z	0
F7PMBAM	Applied Mathematics	KZ	4
The course deals with practical applications of mathematics and its demonstrations with examples from the field of biomedical engineering.			
F7PMBBSC	Biotransport	Z,ZK	5
Basic concepts of a systemic approach to the human body. Functional organization of living organisms. Integrated functions and importance of systems providing applications for biomedical technicians and engineers. Principles of experimental and examination methods used in physiology and medicine. Examples of application of modern technologies in medicine.			
F7PMBCZS	Digital Signal Processing	Z,ZK	5
The course deals with the following topics - characteristics of signals, linear time invariant systems (LTI), stationary, non-stationary signals, deterministic, ergodic and stochastic processes, description of signals in continuous and discrete domains, A/D conversions and converters, sampling and quantization problems, aliasing and Nyquist's theorem, noise suppression and data preprocessing, fast and discrete Fourier transforms, efficient FFT estimation methods, other discrete transforms: z-transform, its properties and applications in DSP, inverse transforms, poles and zeros of the system, frequency response, correlation and convolution, introduction to digital filter design, FIR and IIR filters and adaptive filters,			

spectral analysis and spectrum estimation methods, current methods of analysis in time and frequency domain, coherence and phase characteristics, parametric and non-parametric methods, periodogram and AR spectrum.

F7PMBCZT	Certification of Medical Technology	Z,ZK	3

The course deals with the issue of placing medical devices on the market. The syllabus of the course is designed to cover the main steps in the process of CE marking and marketing.

F7PMBDAE	Product Design and Ergonomy in Health Care	Z	4

The subject deals with the following topics - the concept of design and its definition, basic concepts of design theory, design classification, function of design. Design as a science, design process, design approaches, design methods. Design analysis. Design and marketing, brand policy. Perspective view, geometric forms, problems of shape perception and composition. Ergonomics - definitions, terms. The role and place of ergonomics in design. Ergonomics in the workplace. Human (patient) - its physical characteristics, dimensions, human body, sensations and perceptions, reflexes, human psychological characteristics, interpersonal relationships, voluntary act, motivation, efficiency, work organization. Handicap. Human and medical product. Aids, instruments and tools. Climate conditions. Lighting. Noise. Vibration and shock. Safety. Interior of medical facility (color, lighting, materials). Universal design / Design for all, 7 basic principles. Design of medical devices, principles of design in healthcare.

F7PMBDP	Diploma Thesis	Z	12

Independent work of the student at the end of the study, when the student has to demonstrate the ability to independently and comprehensively process the given topic using the knowledge acquired during the study. The student chooses the topic of the thesis from the topics offered by the department that guarantees the study programme. The student is obliged to write the thesis at the beginning of the 4th semester. In this semester the thesis is submitted and defended. The student defends his/her thesis in front of the SZZ committee. This thesis is evaluated by the supervisor and the opponent according to the ECTS grading scale. Subsequently, the evaluation and the result of the final state examination from the thematic areas are included in one final evaluation.

F7PMBDS1	Diploma Thesis Seminar I.	Z	5

The diploma seminar serves as a support for the start of work on the diploma thesis. During the semester, students present the intended aims and methods of their thesis and the partial results of their work.

F7PMBDS2	Diploma Thesis Seminar II.	Z	3

The Diploma Seminar II is a continuation of the course Diploma Seminar I. The follow-up activity in the solution of the diploma thesis is controlled during the seminar. In particular, the intermediate results of the diploma thesis are checked, which students present during the semester.

F7PMBEMEO	Electrotechnology and Modern Electronic Circuits	Z,ZK	5

The course deals with the following topics: sub-blocks of communication (low-current/powe) and power (high-current/power) electrical engineering, which relate mainly to applications of modern digital and / or analog-digital circuits or digital-analog circuits especially in the field of drive control and actuator), basic concepts and requirements for these circuits, such as their power supply, load capacity, connection to other peripherals, etc., emphasis is also placed on the principles and applications of synchronous and asynchronous communication lines (SPI, I2C, OneWire, USART), programmable circuits (principles of programmable logic, overview of programmable circuits - PAL, GAL, CPLD, FPGA, circuit programming procedures), microcontrollers and microprocessors (8-bit, 16-bit and 32-bit architecture), systems for galvanic isolation of signal and power supply (optocouplers, linear separators, data bus separators), power drivers for motors and other actuators (H-bridges , triac and thyristor control, IGBT transistors).

F7PMBKB	Clinical Biochemistry and Laboratory Diagnostic Methods	Z,ZK	5

The course deals with the following topics - biochemistry of the human organism, important metabolic and regulatory pathways and disorders of these processes, possibilities of diagnosis of these disorders and procedures of relevant laboratory tests, activities of the clinical laboratory, processing of data from methods used in clinical laboratories.

F7PMBKST	Quality, Reliability, Testing of Medical Devices	ZK	3

The aim of the course is to familiarize students with aspects that affect the quality, reliability and testing of medical products, i.e. quality management in healthcare. The course will discuss both the related standards used and the individual methods used in quality and reliability management of medical devices.

F7PMBMAR	Measurements and Control in Biomedicine	Z,ZK	5

The course deals with the following topics - measurement of electrical and non-electrical quantities using conventional laboratory instruments, industrial A/D converters and digitizing cards such as DAQ, low-cost solutions with MCUs such as Arduino, as well as factors affecting the accuracy and stability of measurements both at the level of the sensors and converters themselves, as well as the correct interpretation of these data and the expression of measurement uncertainty and calibration, Machine vision, with a focus on camera systems and standards, and the basics of image recognition, control will include the fundamentals of automation, design of state and sequential automata, addressing transport delay and design of threshold and proportional controllers, demonstrations on biomedical applications, and new trends in measurement, control and automation using FPGA and real-time gate array technology.

F7PMBMTB	Fluid Mechanics in Biomedicine	Z,ZK	5

The course deals with the following topics - modelling and measurement of fluid flow in respiratory care and cardiovascular system, creation of models of respiratory and cardiovascular system, application of fluid mechanics principles in research and development as well as in clinical practice.

F7PMBNPM	Nanotechnology for Medicine	Z,ZK	3

The course introduces students to nanomaterials that can be used in modern analytical and diagnostic methods in nanomedicine. The course lectures focus on nanoparticles, their basic characteristics such as size and chemical potential, their preparation methods and surface functionalization. The course also covers the optical characteristics of nanomaterials and the basics of luminescence and phosphorescence principles and their detection using confocal principles. In the last part of the course, magnetic properties of nanoparticles and nano-NMR detection methods are presented and examples used for optical and magnetic methods in nanomedicine for detection of targeted nanoparticles.

F7PMBOP1	Internship I.	Z	2

Professional Practice I complements the practical part of the Biomedical Engineering programme. Students get to know in practice and in more detail the activities and work of a biomedical engineer in medical institutions, specifically in routine clinical operation. The professional practice is designed so that the student spends at least 30 hours in practice in health care facilities at workplaces using diagnostic medical devices including imaging methods, at least 20 hours at workplaces using therapeutic medical devices and at least 10 hours at workplaces using laboratory medical devices. The work experience shall also include at least 5 hours in the technical and operational section, focusing on medical gases, compressor stations and back-up power supplies, and 5 hours in the metrology section. During the internship, the student will get acquainted with processes and procedures that are directly related to the daily activities of a biomedical engineer with activity in clinical operation: the issue of evaluating failures of medical devices and technologies, including corrective solutions, implementation of regular calibration or verification of measuring instruments, implementation of regular safety and technical checks of medical devices, acceptance of delivered medical equipment including the necessary documentation, etc.

F7PMBOP2	Internship II.	Z	2

Professional Practice II complements the practical part of the Biomedical Engineering programme and directly follows the practice implemented between the first and second semesters within the Professional Practice I block. Practical training in the second block can continue in a medical facility or can take place at other departments of organisations dealing with administrative issues in the field of biomedical engineering, e.g. at the Electrotechnical Testing Institute or the State Office for Drug Control, etc. During the internship, the student will get acquainted with legislative and administrative processes that are directly related to the activity of a biomedical engineer: the issue of selection procedures and the choice of technical parameters of medical equipment for the needs of the selection procedure, participation in the evaluation of selection procedures, etc. An essential part of the professional practice II is at least 10 hours in the field of medical devices and measuring instruments registration, especially with emphasis on orientation in database systems used in healthcare and at least 10 hours of familiarisation with information systems, NIS, KIS, PACS and patient data security issues. This may include participation in auditing activities, analysis of adverse events in connection with medical technology, etc.

F7PMBOP3	Internship III.	Z	2

Professional Practice III builds on previous blocks of professional practice and complements the practical part of the Biomedical Engineering programme. The third block of internship will typically take place in a workplace that is closely related to the topic of the student's thesis. In the third block, the internship may take place in a healthcare facility, government

	organizations or even in commercial companies in the field of biomedical engineering. The internship may include the implementation of measurements requiring specific equipment not available at the Faculty of Biomedical Engineering. The implementation of the internship is always subject to the approval of the course supervisor.		
F7PMBPIZ	Work with Information Sources and Research Methodology	KZ	4
	The course deals with the following topics - characteristics of research and science, types of research, relation to legislation and financial sources, research projects, grant applications and the grant process, basic characteristics and specifics of a professional text, content of individual sections, publishing practices, publishing ethics, citation of sources, information sources, typographical rules, mathematical typesetting, proofreading of texts, principles for creating presentations, presentation of results in the form of tables, graphs, diagrams and charts.		
F7PMBPMZD	Advanced Methods of Analysis and Data Processing	KZ	3
	This course comprehends/deals methods of biosignal generation, biosignal acquisition and basic parameters of biosignals required for diagnostics. Methods and algorithms for biosignal processing, analysis and evaluation used for biological signals, mainly electrophysiological signals. Preprocessing, filtering, time and frequency analysis. Use of modern spectral analysis methods. Visualisation of results, topographic mapping, method of compressed spectral arrays (CSA). Adaptive segmentation of non-stationary signals is discussed. Application of methods using artificial intelligence. Methods of automated signal classification - supervised/unsupervised, cluster analysis, learning classifier. Artificial neural networks (ANN). Practical application of biosignal processing. Case studies of ANN application on epileptogenic recordings and neural recordings in general. Genetic algorithms and simulated annealing is presented.		
F7PMBPOD	Entrepreneurship	KZ	3
	Students will get a general overview of the company and its key functional areas. Students will be able to identify the elements of success of entrepreneurial ventures, consider the legal and financial conditions for starting a business venture, also evaluate the effectiveness of different entrepreneurial strategies. Finally students will be able to specify the basic performance indicators of entrepreneurial activity and explain the importance of marketing and management in businesses. At the end of the course students will interpret their own business plan.		
F7PMBPPTD	Advanced Medical Devices for Diagnostics	Z,ZK	4
	The course deals with advanced issues focused on diagnostics in medicine.		
F7PMBPTT	Advanced Medical Devices for Therapy	ZK	3
	The course deals with the following topics - instrumentation used in surgical fields and selected therapeutic devices used in various fields of medicine, physical principles of the devices, safety aspects of their operation, including the relationship to technical standards and specific clinical applications.		
F7PMBRP	Semester Project	Z	3
	Within the year-long project, students choose the topic of an individual project in the field of biomedical engineering, which represents the first stage of the master's thesis. The topics from which students choose are available in the "Projects" database. Students can also provide their own assignment, which must be approved by the programme supervisor and the Head of Department. The main objective of the individual project is to generate a suitable thesis topic based on the current state of the art. The output of the year-long project is a description of the objectives of the follow-up thesis, an overview of the planned methods and the expected outputs and contributions in the field of biomedical engineering.		
F7PMBSPB	Statistics for Biomedicine	Z,ZK	5
	The course deals with the following topics - methods of statistical analysis intended primarily for medical research - clinical, biological, biochemical, biophysical and other studies, methods of descriptive and inductive statistics, statistical epidemiological methods, hypothesis testing, comparison of groups (parametric and non-parametric methods), ANOVA, correlation and simple regression analysis, multivariate regression models, multivariate linear models, logistic regression, discriminant analysis, survival analysis, etc, model calculations and interpretation of results.		
F7PMBSPMM	Software for Mathematical Modeling	Z,ZK	5
F7PMBTVZ	Technical Equipment for Health Care Facilities, the Infrastructure and Architecture	ZK	3
	The course deals with the following topics - infrastructure of a medical facility and its architecture, media distribution (utility networks - electrical wiring, specifics of circuits, water, gas distribution, power systems, power supplies, drives, compensation, spaces in healthcare - specifics of individual spaces, steam distribution systems), practical exercises in the area of project development, familiarization with the necessary related Czech technical norms and standards of the Ministry of Health of the Czech Republic, which specify all the requirements for various types of premises and equipment, focus on barrier-free healthcare facilities.		
F7PMBVZ	Public Health, Management of Medical Facilities	ZK	3
F7PMBZAO	Image Processing and Analysis	Z,ZK	5
	The course deals with the topics - digital image processing vs. computer vision, the role of interpretation, objects in the image, digital image, distance transformation, histogram of brightness, image acquisition from the geometric and radiometric point of view, Fourier transform, derivation of the sampling theorem, frequency filtering of image, PCA, brightness transformation, geometric transformations, interpolation, registration, processing in the spatial domain, convolution, correlation, noise filtering, edge detection, linear and nonlinear methods, mathematical morphology, image compression, color images, texture, segmentation of objects in images, description of objects in images, and their recognition.		
F7PMBZMO	Medical Imaging Processing	Z	3
F7PMBZPO	Introduction to Law and the Protection of Industrial Property	ZK	3
	Předmět je koncipován jako přehled základních legislativních předpisů ve zdravotnictví z oblasti medicínského práva, ochrany duševního vlastnictví. V rámci předmětu se student seznámí s nejrůznějšími zákony v dané oblasti. Předmět se zabývá následujícími tématy - problematika zdravotnické legislativy, základy práva a správního procesu, principy a zásady zdravotnické legislativy, stěžejní zákony pro biomedicínské inženýrství, nákup zdravotnické techniky, medicínské právo - informovaný souhlas, poučení pacienta, odmítnutí zdravotní péče, ukončení péče o pacienta, průmyslové vlastnictví a jeho ochrana (patenty, vzory), právní ochrana duševního vlastnictví.		

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