Study plan

Name of study plan: Medical Electronics and Bioinformatics - Specialization Signal Processing

Faculty/Institute/Others: Faculty of Electrical Engineering
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Medical Electronics and Bioinformatics
Type of study: Follow-up master full-time
Required credits: 114
Elective courses credits: 6
Sum of credits in the plan: 120
Note on the plan:

Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 60
The role of the block: P

Code of the group: 2018_MBIOEP
Name of the group: Compulsory subjects of the programme
Requirement credits in the group: In this group you have to gain 30 credits
Requirement courses in the group: In this group you have to complete 5 courses
Credits in the group: 30
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
BEAM31BSG	**Biological signals** *Petr Ježdík, Roman Čmejla, Michal Novotný* ***Roman Čmejla*** *Roman Čmejla (Gar.)*	Z,ZK	6	2P+2L	L	P
BEMPROJ6	**Diploma Project** *Petr Pošík* ***František Rund***	Z	6	0p+6s	Z,L	P
BEAM33ZSL	**Medical Imaging Systems** *Robert Holaj, Jan Kybic, André Sopczak, Jan Petr* ***Jan Kybic*** *Jan Kybic (Gar.)*	Z,ZK	6	2P+2C	L	P
BEAM31LET	**Medical Instrumentation and Devices** *Jan Havlík* ***Jan Havlík*** *Jan Havlík (Gar.)*	Z,ZK	6	2P+2L	Z	P
BE4M36SAN	**Statistical data analysis** *Jiří Kléma* ***Jiří Kléma*** *Jiří Kléma (Gar.)*	Z,ZK	6	2P+2C	Z	P

Characteristics of the courses of this group of Study Plan: Code=2018_MBIOEP Name=Compulsory subjects of the programme

BEAM31BSG	Biological signals	Z,ZK	6
The course is focused to the native and evoked biosignals used in clinical medicine and current methods of capturing, processing, recording and evaluating in the time and frequency domains. For important biological signals, the students are introduced with their genesis, and nature and physiological characteristics of the signals required for construction of instruments. Students are introduced also with the physical and mathematical models. In laboratory exercises, students have the opportunity to capture their own biological signals and their subsequent processing in MATLAB.			
BEMPROJ6	Diploma Project	Z	6
Independent work in the form of a project. A student will choose a topic from a range of topics related to his or her branch of study, which will be specified by branch department or branch departments. The project will be defended within the framework of a subject.			
BEAM33ZSL	Medical Imaging Systems	Z,ZK	6
The course covers the principles, design and properties of currently used medical imaging devices. We shall deal with 2D microscopic, X-ray and ultrasound imaging systems, including advanced topics such as Doppler ultrasound. We will also study tomographic (3D) imaging systems: computed tomography (CT), magnetic resonance imaging (MRI) including functional MRI (fMRI) and nuclear imaging methods (PET,SPECT). For more information see https://cw.fel.cvut.cz/wiki/courses/zsl			
BEAM31LET	Medical Instrumentation and Devices	Z,ZK	6
Students will study fundamental principles applied within the modern medical devices and systems, esp. from the point of view of functional blocks and electronic circuits of diagnostical and therapeutical medical equipments including electrocardiographs, electroencephalographs, bedside and central monitors, equipments for anestesiology, intensive and critical healthcare, equipments for clinical laboratory, electrostimulators, cardiostimulators and defibrilators, blood pressure and flow measurement (including dilution) and pulse oxymetry.			
BE4M36SAN	Statistical data analysis	Z,ZK	6
This course builds on the skills developed in introductory statistics courses. It is practically oriented and gives an introduction to applied statistics. It mainly aims at multivariate statistical analysis and modelling, i.e., the methods that help to understand, interpret, visualize and model potentially high-dimensional data. It can be seen as a purely statistical counterpart to machine learning and data mining courses.			

Code of the group: 2018_MBIOEDIP
Name of the group: Diploma Thesis
Requirement credits in the group: In this group you have to gain 30 credits
Requirement courses in the group: In this group you have to complete 1 course
Credits in the group: 30
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
BDIP30	**Diploma Thesis**	Z	30	22s	L	P

Characteristics of the courses of this group of Study Plan: Code=2018_MBIOEDIP Name=Diploma Thesis

BDIP30	Diploma Thesis	Z	30

Independent final comprehensive work for the Master's degree study programme. A student will choose a topic from a range of topics related to his or her branch of study, which will be specified by branch department or branch departments. The diploma thesis will be defended in front of the board of examiners for the comprehensive final examination.

Name of the block: Povinné předměty specializace
Minimal number of credits of the block: 30
The role of the block: PS

Code of the group: 2018_MBIOEPS4
Name of the group: Compulsory subjects of specialization - specialization Signal processing
Requirement credits in the group: In this group you have to gain 30 credits
Requirement courses in the group: In this group you have to complete 5 courses
Credits in the group: 30
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
BEAM31ADA	**Adaptive signal processing** *Pavel Sovka **Radoslav Bortel** Radoslav Bortel (Gar.)*	Z,ZK	6	2P+2C	Z	PS
BEAM31ZAS	**Analog Signal Processing** *Jiří Hospodka **Jiří Hospodka** Jiří Hospodka (Gar.)*	Z,ZK	6	2P+2C	L	PS
BE2M31DSPA	**Digital Signal Processing** *Petr Pollák **Petr Pollák** Petr Pollák (Gar.)*	Z,ZK	6	2P+2C	Z	PS
BEAM31MOA	**Modeling and analysis of brain activity** *Jaroslav Hlinka **Jaroslav Hlinka** Jaroslav Hlinka (Gar.)*	Z,ZK	6	2P+2C	Z	PS
BEAM31NPG	**Neurophysiology** *Přemysl Jiruška **Přemysl Jiruška** Přemysl Jiruška (Gar.)*	Z,ZK	6	2P+2C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=2018_MBIOEPS4 Name=Compulsory subjects of specialization - specialization Signal processing

BEAM31ADA	Adaptive signal processing	Z,ZK	6

This course provides a basic discourse on adaptive algorithms for filtering, decorrelation, separation and beamforming. The course explains adaptive algorithms for estimation and prediction, including analysis, implementation and practical applications. Next, it describes the algorithms for adaptive decorrelation and separation of multidimensional signals. Last, the course provides analysis of adaptive beamforming techniques.

BEAM31ZAS	Analog Signal Processing	Z,ZK	6

The course deals with analog input-output blocks for signal transmission and processing. They discussed circuit solution of amplifiers and filters, including their design process, simulation and measurement. Students learn the circuit concepts and possibilities for solving the contemporary analogue structures. The second part of the course describes the design and implementation of analog filters, including discrete-time circuits. The conclusion is devoted to the possibilities of computer optimization of electronic circuits and filters.

BE2M31DSPA	Digital Signal Processing	Z,ZK	6

The subject gives overview about basic methods of digital signal processing and their applications (examples from speech and biological signal processing): disrete-time signals and systems, signal characteristics in time and frequency domain, Fourier transform, fast algorithms for DFT computation, introduction to digital filter design, digital filtering in time and frequency domain, decimation and interpolation and their usage in filter banks, basics of LPC analysis. Further details can be found at http://noel.feld.cvut.cz/vyu/be2m31dspa .

BEAM31MOA	Modeling and analysis of brain activity	Z,ZK	6
BEAM31NPG	Neurophysiology	Z,ZK	6

The course will provide an introduction to the structure and function of the neural system and the mechanisms behind major diseases of the human brain. It will combine topics from various disciplines ranging from electrophysiology, neurobiology, neuroanatomy, neurology, psychiatry to biophysics and bioengineering. Understanding the principles how the human brain works in health and disease represents a crucial prerequisite for the development and implementation of modern engineering technologies to better diagnose and treat brain disorders.

Name of the block: Compulsory elective courses

Minimal number of credits of the block: 24
The role of the block: PV

Code of the group: 2018_MBIOEPPV4
Name of the group: Compulsory elective subjects of the programme
Requirement credits in the group: In this group you have to gain 24 credits
Requirement courses in the group: In this group you have to complete 4 courses
Credits in the group: 24
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
BE4M33PAL	**Advanced Algorithms** *Marko Genyk-Berezovskyj, Daniel Průša* ***Daniel Průša*** *Daniel Průša (Gar.)*	Z,ZK	6	2P+2C	Z	PV
BEAM17EPM	**Applications of Electromagnetic Fields in Medicine**	Z,ZK	6	2P+2L	L	PV
BEAM31AOL	**Applied optoelectronics in medicine** ***Jan Havlík*** *Jan Havlík (Gar.)*	Z,ZK	6	2P+2C	L	PV
BEAM36BIN	**Bioinformatics** *Jiří Kléma* ***Jiří Kléma*** *Jiří Kléma (Gar.)*	Z,ZK	6	2P+2C	L	PV
BEAM02BIO	**Biosensors** *Bohuslav Rezek* ***Bohuslav Rezek*** *Bohuslav Rezek (Gar.)*	Z,ZK	6	2P+2L	Z	PV
BE4M35KO	**Combinatorial Optimization** *Zdeněk Hanzálek* ***Zdeněk Hanzálek***	Z,ZK	6	3P+2C	L	PV
BE4M33MPV	**Computer Vision Methods** *Georgios Tolias, Jiří Matas, Jan Čech, Dmytro Mishkin, Ondřej Drbohlav* ***Ondřej Drbohlav*** *Jiří Matas (Gar.)*	Z,ZK	6	2P+2C	L	PV
BEAM38KLS	**Construction of Medical Systems** *Jan Holub* ***Jan Holub*** *Jan Holub (Gar.)*	Z,ZK	6	2P+2L	Z	PV
BEAM17EMC	**Introduction to Electromagnetic Compatibility** *Tomáš Kořínek* ***Tomáš Kořínek*** *Tomáš Kořínek (Gar.)*	Z,ZK	6	2P+2L	Z	PV
BEAM33ZMO	**Medical Image Processing** *Jan Kybic* ***Jan Kybic*** *Jan Kybic (Gar.)*	Z,ZK	6	2P+2C	Z	PV
BEAM33MOS	**Modeling and Simulation** ***Petr Pošík***	Z,ZK	6	2P+2C	Z	PV
BE4M36MBG	**Molecular Biology and Genetics** *Martin Pospíšek* ***Martin Pospíšek*** *Martin Pospíšek (Gar.)*	Z,ZK	6	3P+1C	L	PV
BEAM33NIN	**Neuroinformatics** *Jiří Hammer, Karla Štěpánová, Michal Vavrečka, Ján Antolík, Daniel Novák, Eduard Bakštein, David Kala* ***Daniel Novák*** *Daniel Novák (Gar.)*	Z,ZK	6	2P+2C	L	PV
BEAM02FPT	**Physics for Diagnostics and Therapy** *Vratislav Fabián, Jaroslav Jíra* ***Vratislav Fabián*** *Vratislav Fabián (Gar.)*	Z,ZK	6	2P+2L		PV
BE0M37FAV	**Physiology and modeling of hearing and vision** *Václav Vencovský, Miloš Klíma, Karel Fliegel, Petr Maršálek* ***Karel Fliegel*** *Václav Vencovský (Gar.)*	Z,ZK	6	2P+2C+4D	Z	PV
BE4M33SSU	**Statistical Machine Learning** *Jan Drchal, Vojtěch Franc, Boris Flach* ***Vojtěch Franc*** *Boris Flach (Gar.)*	Z,ZK	6	2P+2C	Z	PV
BE4M36SMU	**Symbolic Machine Learning** *Filip Železný, Ondřej Kuželka, Gustav Šír* ***Ondřej Kuželka*** *Ondřej Kuželka (Gar.)*	Z,ZK	6	2P+2C	L	PV

Characteristics of the courses of this group of Study Plan: Code=2018_MBIOEPPV4 Name=Compulsory elective subjects of the programme

BE4M33PAL	Advanced Algorithms	Z,ZK	6
Basic graph algorithms and graph representation. Combinatorial algorithms. Application of formal languages theory in computer science - pattern matching.			
BEAM17EPM	Applications of Electromagnetic Fields in Medicine	Z,ZK	6
The major aim of these lectures is to give to students a basic overview of biophysical aspects of EM fields in different biological systems, including an overview of microwave applications in medicine. Safety limits, clinical usage of EM field effects on biological systems, microwave hyperthermia, measurement of dielectric parameters of biological tissues, EM exposure of mobile phone users, magnetic resonance imaging, interaction of optical radiation with biological tissue.			
BEAM31AOL	Applied optoelectronics in medicine	Z,ZK	6
BEAM36BIN	Bioinformatics	Z,ZK	6
BEAM02BIO	Biosensors	Z,ZK	6
This course introduces the physical, electronic, biological principles of biosensors and provides information on past, present and future technologies. Various mechanisms and sensor concepts for specific applications (such as detection of glucose, urea, proteins, cells, bacteria, etc.) are explained. In addition, the course introduces the use of modern nanostructures and nanomaterials in biosensors to achieve reliable and sensitive devices for diagnosis at the point of care, in food safety or environmental monitoring. We will also discuss current challenges and future perspectives for various applications of biosensors.			
BE4M35KO	Combinatorial Optimization	Z,ZK	6
The goal is to show the problems and algorithms of combinatorial optimization (often called discrete optimization; there is a strong overlap with the term operations research). Following the courses on linear algebra, graph theory, and basics of optimization, we show optimization techniques based on graphs, integer linear programming, heuristics, approximation algorithms and state space search methods. We focus on application of optimization in stores, ground transportation, flight transportation, logistics, planning of human resources, scheduling in production lines, message routing, scheduling in parallel computers.			

BE4M33MPV	Computer Vision Methods	Z,ZK	6
The course covers selected computer vision problems: search for correspondences between images via interest point detection, description and matching, image stitching, detection, recognition and segmentation of objects in images and videos, image retrieval from large databases and tracking of objects in video sequences. This course is also part of the inter-university programme prg.ai Minor. It pools the best of AI education in Prague to provide students with a deeper and broader insight into the field of artificial intelligence. More information is available at https://prg.ai/minor.			
BEAM38KLS	Construction of Medical Systems	Z,ZK	6
General principles and design and construction of medical devices and systems. Technical standards and requirements for the design, construction and operation of medical electrical appliances. Classification classes of instruments. Electromagnetic Compatibility of Medical Devices. Modern component base. Design and construction of basic blocks of medical devices.			
BEAM17EMC	Introduction to Electromagnetic Compatibility	Z,ZK	6
The course dwells on problems of electromagnetic compatibility. Students obtain the basic knowledges in the field of electromagnetic compatibility - electromagnetic interference, susceptibility and testing methods. The course leads to gain professional skills in the field of electrical engineering.			
BEAM33ZMO	Medical Image Processing	Z,ZK	6
This subject describes algorithms for digital image processing of 2D and 3D images, with emphasis on biomedical applications. We shall therefore concentrate on the most often used techniques in medical image processing: segmentation, registration, and classification. The methods will be illustrated by a range of examples on medical data. The students will implement some of the algorithms during the practice sessions. Because of the very large overlap between courses A6M33ZMO and A4M33ZMO, the courses will be taught together this year.			
BEAM33MOS	Modeling and Simulation	Z,ZK	6
The modelling techniques being frequently used in biomedical engineering and corresponding software tools: Matlab-Simulink, Modelica. Techniques of modelling and processes associated with them. Types of models, continuous and discrete time models, linear and nonlinear models with lumped parameters, models and their implementation in program environment. Formalization and model creation for a selected system, its identification, verification and interpretation. Equilibrium states (homeostasis) and their inquiry by simulation. Models of open and feedback systems. Use of fuzzy-neuronal models in biomedicine. Models of separate systems and whole constellations being defined in biomedical engineering. Models of cellular and physiological control, population models. Application of models for artificial organs production.			
BE4M36MBG	Molecular Biology and Genetics	Z,ZK	6
BEAM33NIN	Neuroinformatics	Z,ZK	6
The Neuroinformatics Course concentrates on modelling of neurons, stochastic learning on cellular level, information coding and decoding in brain and single unit processing. Examples from clinical practices are provided throughout the course. The labs focus on signal neuron analysis from human and animal brain.			
BEAM02FPT	Physics for Diagnostics and Therapy	Z,ZK	6
In this course, students will be introduced to the problems of locomotive organs diseases and musculoskeletal pain in the first seven lectures. Great space is devoted to electrotherapeutic methods, therapeutic ultrasound and phototherapy. Furthermore, advanced neurorehabilitation methods, especially transcranial brain stimulation methods (repetitive transcranial magnetic stimulation of the brain - rTMS, transcranial electrical stimulation of the brain - tDCS and electroconvulsive therapy - ECT) are discussed. In the second half of the semester, attention is paid to the possibilities of using ionizing electromagnetic fields in medical diagnostics and therapy (eg X-ray, proton therapy, radiotherapy, etc.).			
BE0M37FAV	Physiology and modeling of hearing and vision	Z,ZK	6
The primary aim of the course is to study the physiology of sensors and processes of perception of audio and visual information by human subjects as two central and most important communication channels, i.e., Human Auditory System (HAS) and Human Visual System (HVS). The course summarizes current knowledge in the field of human vision and hearing physiology and, at the same time, presents their description using mathematical models using the latest computational tools and procedures, including Machine Learning (ML), Deep Learning (DL) and Artificial Intelligence (AI). Emphasis is also placed on current and prospective applications of the mentioned knowledge. The main application area is the audiovisual technology related to human perception, but the direct employment of the acquired knowledge also includes the areas of multimedia technology, control systems, automation, robotics, safety and security technology, bioinspired systems, etc. At the same time, students gain a general overview of information processing in biological systems. A separate part is the objectification of audiovisual information perceived quality, i.e., Quality of Experience (QoE). The course is intended for students of master's degree in technical fields. The exercises will be devoted to fundamental experiments to determine the most important characteristics of HAS and HVS, including computational models and simulation of vision and hearing processes.			
BE4M33SSU	Statistical Machine Learning	Z,ZK	6
The aim of statistical machine learning is to develop systems (models and algorithms) for learning to solve tasks given a set of examples and some prior knowledge about the task. This includes typical tasks in speech and image recognition. The course has the following two main objectives 1. to present fundamental learning concepts such as risk minimisation, maximum likelihood estimation and Bayesian learning including their theoretical aspects, 2. to consider important state-of-the-art models for classification and regression and to show how they can be learned by those concepts.			
BE4M36SMU	Symbolic Machine Learning	Z,ZK	6
This course consists of three parts. The first part of the course will explain methods through which an intelligent agent can learn by interacting with its environment, also known as reinforcement learning. This will include deep reinforcement learning. The second part focuses on Bayesian networks, specifically methods for inference. The third part will cover fundamental topics from natural language learning, starting from the basics and ending with state-of-the-art architectures such as transformer. Finally, the last part will provide an introduction to several topics from the computational learning theory, including the online and batch learning settings.			

Name of the block: Elective courses
Minimal number of credits of the block: 0
The role of the block: V

Code of the group: 2018_MBIOEVOL
Name of the group: Elective subjects
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: ~Student can choose arbitrary subject of the magister's program (EEM - Electrical Engineering, Power Engineering and Management, EK - Electronics and Communications, KYR - Cybernetics and Robotics, OI - Open Informatics, OES - Open Electronics Systems) which is not part of his curriculum. Student can choose with consideration of recommendation of the branch guarantee.You can find a selection of optional courses organized by the departments on the web site http://www.fel.cvut.cz/cz/education/volitelne-predmety.html

List of courses of this pass:

Code	Name of the course	Completion	Credits
BDIP30	Diploma Thesis	Z	30
Independent final comprehensive work for the Master's degree study programme. A student will choose a topic from a range of topics related to his or her branch of study, which will be specified by branch department or branch departments. The diploma thesis will be defended in front of the board of examiners for the comprehensive final examination.			
BE0M37FAV	Physiology and modeling of hearing and vision	Z,ZK	6
The primary aim of the course is to study the physiology of sensors and processes of perception of audio and visual information by human subjects as two central and most important communication channels, i.e., Human Auditory System (HAS) and Human Visual System (HVS). The course summarizes current knowledge in the field of human vision and hearing physiology and, at the same time, presents their description using mathematical models using the latest computational tools and procedures, including Machine Learning (ML), Deep Learning (DL) and Artificial Intelligence (AI). Emphasis is also placed on current and prospective applications of the mentioned knowledge. The main application area is the audiovisual technology related to human perception, but the direct employment of the acquired knowledge also includes the areas of multimedia technology, control systems, automation, robotics, safety and security technology, bioinspired systems, etc. At the same time, students gain a general overview of information processing in biological systems. A separate part is the objectification of audiovisual information perceived quality, i.e., Quality of Experience (QoE). The course is intended for students of master's degree in technical fields. The exercises will be devoted to fundamental experiments to determine the most important characteristics of HAS and HVS, including computational models and simulation of vision and hearing processes.			
BE2M31DSPA	Digital Signal Processing	Z,ZK	6
The subject gives overview about basic methods of digital signal processing and their applications (examples from speech and biological signal processing): disrete-time signals and systems, signal characteristics in time and frequency domain, Fourier transform, fast algorithms for DFT computation, introduction to digital filter design, digital filtering in time and frequency domain, decimation and interpolation and their usage in filter banks, basics of LPC analysis. Further details can be found at http://noel.feld.cvut.cz/vyu/be2m31dspa .			
BE4M33MPV	Computer Vision Methods	Z,ZK	6
The course covers selected computer vision problems: search for correspondences between images via interest point detection, description and matching, image stitching, detection, recognition and segmentation of objects in images and videos, image retrieval from large databases and tracking of objects in video sequences. This course is also part of the inter-university programme prg.ai Minor. It pools the best of AI education in Prague to provide students with a deeper and broader insight into the field of artificial intelligence. More information is available at https://prg.ai/minor.			
BE4M33PAL	Advanced Algorithms	Z,ZK	6
Basic graph algorithms and graph representation. Combinatorial algorithms. Application of formal languages theory in computer science - pattern matching.			
BE4M33SSU	Statistical Machine Learning	Z,ZK	6
The aim of statistical machine learning is to develop systems (models and algorithms) for learning to solve tasks given a set of examples and some prior knowledge about the task. This includes typical tasks in speech and image recognition. The course has the following two main objectives 1. to present fundamental learning concepts such as risk minimisation, maximum likelihood estimation and Bayesian learning including their theoretical aspects, 2. to consider important state-of-the-art models for classification and regression and to show how they can be learned by those concepts.			
BE4M35KO	Combinatorial Optimization	Z,ZK	6
The goal is to show the problems and algorithms of combinatorial optimization (often called discrete optimization; there is a strong overlap with the term operations research). Following the courses on linear algebra, graph theory, and basics of optimization, we show optimization techniques based on graphs, integer linear programming, heuristics, approximation algorithms and state space search methods. We focus on application of optimization in stores, ground transportation, flight transportation, logistics, planning of human resources, scheduling in production lines, message routing, scheduling in parallel computers.			
BE4M36MBG	Molecular Biology and Genetics	Z,ZK	6
BE4M36SAN	Statistical data analysis	Z,ZK	6
This course builds on the skills developed in introductory statistics courses. It is practically oriented and gives an introduction to applied statistics. It mainly aims at multivariate statistical analysis and modelling, i.e., the methods that help to understand, interpret, visualize and model potentially high-dimensional data. It can be seen as a purely statistical counterpart to machine learning and data mining courses.			
BE4M36SMU	Symbolic Machine Learning	Z,ZK	6
This course consists of three parts. The first part of the course will explain methods through which an intelligent agent can learn by interacting with its environment, also known as reinforcement learning. This will include deep reinforcement learning. The second part focuses on Bayesian networks, specifically methods for inference. The third part will cover fundamental topics from natural language learning, starting from the basics and ending with state-of-the-art architectures such as transformer. Finally, the last part will provide an introduction to several topics from the computational learning theory, including the online and batch learning settings.			
BEAM02BIO	Biosensors	Z,ZK	6
This course introduces the physical, electronic, biological principles of biosensors and provides information on past, present and future technologies. Various mechanisms and sensor concepts for specific applications (such as detection of glucose, urea, proteins, cells, bacteria, etc.) are explained. In addition, the course introduces the use of modern nanostructures and nanomaterials in biosensors to achieve reliable and sensitive devices for diagnosis at the point of care, in food safety or environmental monitoring. We will also discuss current challenges and future perspectives for various applications of biosensors.			
BEAM02FPT	Physics for Diagnostics and Therapy	Z,ZK	6
In this course, students will be introduced to the problems of locomotive organs diseases and musculoskeletal pain in the first seven lectures. Great space is devoted to electrotherapeutic methods, therapeutic ultrasound and phototherapy. Furthermore, advanced neurorehabilitation methods, especially transcranial brain stimulation methods (repetitive transcranial magnetic stimulation of the brain - rTMS, transcranial electrical stimulation of the brain - tDCS and electroconvulsive therapy - ECT) are discussed. In the second half of the semester, attention is paid to the possibilities of using ionizing electromagnetic fields in medical diagnostics and therapy (eg X-ray, proton therapy, radiotherapy, etc.).			
BEAM17EMC	Introduction to Electromagnetic Compatibility	Z,ZK	6
The course dwells on problems of electromagnetic compatibility. Students obtain the basic knowledges in the field of electromagnetic compatibility - electromagnetic interference, susceptibility and testing methods. The course leads to gain professional skills in the field of electrical engineering.			
BEAM17EPM	Applications of Electromagnetic Fields in Medicine	Z,ZK	6
The major aim of these lectures is to give to students a basic overview of biophysical aspects of EM fields in different biological systems, including an overview of microwave applications in medicine. Safety limits, clinical usage of EM field effects on biological systems, microwave hyperthermia, measurement of dielectric parameters of biological tissues, EM exposure of mobile phone users, magnetic resonance imaging, interaction of optical radiation with biological tissue.			

BEAM31ADA	Adaptive signal processing	Z,ZK	6
This course provides a basic discourse on adaptive algorithms for filtering, decorrelation, separation and beamforming. The course explains adaptive algorithms for estimation and prediction, including analysis, implementation and practical applications. Next, it describes the algorithms for adaptive decorrelation and separation of multidimensional signals. Last, the course provides analysis of adaptive beamforming techniques.			
BEAM31AOL	Applied optoelectronics in medicine	Z,ZK	6
BEAM31BSG	Biological signals	Z,ZK	6
The course is focused to the native and evoked biosignals used in clinical medicine and current methods of capturing, processing, recording and evaluating in the time and frequency domains. For important biological signals, the students are introduced with their genesis, and nature and physiological characteristics of the signals required for construction of instruments. Students are introduced also with the physical and mathematical models. In laboratory exercises, students have the opportunity to capture their own biological signals and their subsequent processing in MATLAB.			
BEAM31LET	Medical Instrumentation and Devices	Z,ZK	6
Students will study fundamental principles applied within the modern medical devices and systems, esp. from the point of view of functional blocks and electronic circuits of diagnostical and therapeutical medical equipments including electrocardiographs, electroencephalographs, bedside and central monitors, equipments for anestesiology, intensive and critical healthcare, equipments for clinical laboratory, electrostimulators, cardiostimulators and defibrilators, blood pressure and flow measurement (including dilution) and pulse oxymetry.			
BEAM31MOA	Modeling and analysis of brain activity	Z,ZK	6
BEAM31NPG	Neurophysiology	Z,ZK	6
The course will provide an introduction to the structure and function of the neural system and the mechanisms behind major diseases of the human brain. It will combine topics from various disciplines ranging from electrophysiology, neurobiology, neuroanatomy, neurology, psychiatry to biophysics and bioengineering. Understanding the principles how the human brain works in health and disease represents a crucial prerequisite for the development and implementation of modern engineering technologies to better diagnose and treat brain disorders.			
BEAM31ZAS	Analog Signal Processing	Z,ZK	6
The course deals with analog input-output blocks for signal transmission and processing. They discussed circuit solution of amplifiers and filters, including their design process, simulation and measurement. Students learn the circuit concepts and possibilities for solving the contemporary analogue structures. The second part of the course describes the design and implementation of analog filters, including discrete-time circuits. The conclusion is devoted to the possibilities of computer optimization of electronic circuits and filters.			
BEAM33MOS	Modeling and Simulation	Z,ZK	6
The modelling techniques being frequently used in biomedical engineering and corresponding software tools: Matlab-Simulink, Modelica. Techniques of modelling and processes associated with them. Types of models, continuous and discrete time models, linear and nonlinear models with lumped parameters, models and their implementation in program environment. Formalization and model creation for a selected system, its identification, verification and interpretation. Equilibrium states (homeostasis) and their inquiry by simulation. Models of open and feedback systems. Use of fuzzy-neuronal models in biomedicine. Models of separate systems and whole constellations being defined in biomedical engineering. Models of cellular and physiological control, population models. Application of models for artificial organs production.			
BEAM33NIN	Neuroinformatics	Z,ZK	6
The Neuroinformatics Course concentrates on modelling of neurons, stochastic learning on cellular level, information coding and decoding in brain and single unit processing. Examples from clinical practices are provided throughout the course. The labs focus on signal neuron analysis from human and animal brain.			
BEAM33ZMO	Medical Image Processing	Z,ZK	6
This subject describes algorithms for digital image processing of 2D and 3D images, with emphasis on biomedical applications. We shall therefore concentrate on the most often used techniques in medical image processing: segmentation, registration, and classification. The methods will be illustrated by a range of examples on medical data. The students will implement some of the algorithms during the practice sessions. Because of the very large overlap between courses A6M33ZMO and A4M33ZMO, the courses will be taught together this year.			
BEAM33ZSL	Medical Imaging Systems	Z,ZK	6
The course covers the principles, design and properties of currently used medical imaging devices. We shall deal with 2D microscopic, X-ray and ultrasound imaging systems, including advanced topics such as Doppler ultrasound. We will also study tomographic (3D) imaging systems: computed tomography (CT), magnetic resonance imaging (MRI) including functional MRI (fMRI) and nuclear imaging methods (PET,SPECT). For more information see https://cw.fel.cvut.cz/wiki/courses/zsl			
BEAM36BIN	Bioinformatics	Z,ZK	6
BEAM38KLS	Construction of Medical Systems	Z,ZK	6
General principles and design and construction of medical devices and systems. Technical standards and requirements for the design, construction and operation of medical electrical appliances. Classification classes of instruments. Electromagnetic Compatibility of Medical Devices. Modern component base. Design and construction of basic blocks of medical devices.			
BEMPROJ6	Diploma Project	Z	6
Independent work in the form of a project. A student will choose a topic from a range of topics related to his or her branch of study, which will be specified by branch department or branch departments. The project will be defended within the framework of a subject.			

For updated information see http://bilakniha.cvut.cz/en/f3.html
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