# Recomended pass through the study plan

## Name of the pass: Specialization Medical Instrumentation - Passage through study

Faculty/Institute/Others: Faculty of Electrical Engineering
Department:
Pass through the study plan: Medical Electronics and Bioinformatics - Specialization Medical Instrumentation
Branch of study guranteed by the department: Welcome page
Guarantor of the study branch:
Program of study: Medical Electronics and Bioinformatics
Type of study: Follow-up master full-time
Note on the pass:

**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 |
|---|---|---|---|---|---|---|
| BEAM31LET | **Medical Instrumentation and Devices** *Jan Havlík* ***Jan Havlík*** *Jan Havlík (Gar.)* | Z,ZK | 6 | 2P+2L | Z | P |
| BEEZM | **Safety in Electrical Engineering for a master´s degree** *Vladimír Kůla, Ivana Nová, Josef Černohous, Radek Havlíček* ***Radek Havlíček*** *Vladimír Kůla (Gar.)* | Z | 0 | 2BP+2BC | Z | P |
| BE4M36SAN | **Statistical data analysis** *Jiří Kléma* ***Jiří Kléma*** *Jiří Kléma (Gar.)* | Z,ZK | 6 | 2P+2C | Z | P |
| BE4M33PAL | **Advanced Algorithms** *Marko Genyk-Berezovskyj, Daniel Průša* ***Daniel Průša*** *Daniel Průša (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| BE4M33SSU | **Statistical Machine Learning** *Jan Drchal, Vojtěch Franc, Boris Flach* ***Vojtěch Franc*** *Boris Flach (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| 2018_MBIOEPPV2 | **Compulsory elective subjects of the programme** *BEAM31ADA,BE4M33PAL,..... (see the list of groups below)* | Min. cours. 4 Max. cours. 4 | Min/Max 24/24 | | | PV |

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 |
|---|---|---|---|---|---|---|
| BEAM31BSG | **Biological signals** *Petr Ježdík, Roman Čmejla, Michal Novotný* ***Roman Čmejla*** *Roman Čmejla (Gar.)* | Z,ZK | 6 | 2P+2L | L | P |
| BEAM33ZSL | **Medical Imaging Systems** *Jan Kybic, Robert Holaj, André Sopczak, Jan Petr, André Sopczak* ***Jan Kybic*** *Jan Kybic (Gar.)* | Z,ZK | 6 | 2P+2C | L | P |
| 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 |
| 2018_MBIOEPPV2 | **Compulsory elective subjects of the programme** *BEAM31ADA,BE4M33PAL,..... (see the list of groups below)* | Min. cours. 4 Max. cours. 4 | Min/Max 24/24 | | | PV |

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 |
|---|---|---|---|---|---|---|
| BEMPROJ6 | **Diploma Project** *Jan Kybic, Roman Čmejla, Petr Pošík, Vratislav Fabián* ***Petr Pošík*** *Jan Kybic (Gar.)* | Z | 6 | 0p+6s | Z,L | P |
| BEAM33ZMO | **Medical Image Processing** *Jan Kybic* ***Jan Kybic*** *Jan Kybic (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| 2018_MBIOEPPV2 | **Compulsory elective subjects of the programme** *BEAM31ADA,BE4M33PAL,..... (see the list of groups below)* | Min. cours. 4 Max. cours. 4 | Min/Max 24/24 | | | PV |
| 2018_MBIOEVOL | **Elective subjects** | Min. cours. 0 | Min/Max 0/999 | | | V |

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 |
|---|---|---|---|---|---|---|
| BDIP30 | **Diploma Thesis** | Z | 30 | 22s | L | P |

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

| Kód | Name of the group of courses and codes of members of this group (for specification see here or below the list of courses) | Completion | Credits | Scope | Semester | Role |
|---|---|---|---|---|---|---|
| **2018_MBIOEPPV2** | **Compulsory elective subjects of the programme** | **Min. cours. 4 Max. cours. 4** | **Min/Max** 24/24 | | | **PV** |

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|---|---|---|---|---|---|
| BEAM31ADA | Adaptive signal processing | BE4M33PAL | Advanced Algorithms | BEAM31AOL | Applied optoelectronics in medic ... |
| BEAM36BIN | Bioinformatics | BEAM02BIO | Biosensors | BE4M35KO | Combinatorial Optimization |
| BE4M33MPV | Computer Vision Methods | BE2M31DSPA | Digital Signal Processing | BEAM17EMC | Introduction to Electromagnetic ... |
| BEAM33ZMO | Medical Image Processing | BEAM31MOA | Modeling and analysis of brain a ... | BEAM33MOS | Modeling and Simulation |
| BE4M36MBG | Molecular Biology and Genetics | BEAM33NIN | Neuroinformatics | BE4M33SSU | Statistical Machine Learning |
| BE4M36SMU | Symbolic Machine Learning | | | | |

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|---|---|---|---|---|---|---|
| **2018_MBIOEVOL** | **Elective subjects** | **Min. cours. 0** | **Min/Max** 0/999 | | | **V** |

## 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. | | | |
| 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 <a href=http://noel.feld.cvut.cz/vyu/be2m31dspa>http://noel.feld.cvut.cz/vyu/be2m31dspa</a> . | | | |
| 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. | | | |

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|---|---|---|---|
| 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 four 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. | | | |
| 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. | | | |
| 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 |
| 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 |
| BEEZM | Safety in Electrical Engineering for a master´s degree | Z | 0 |
| The course provides for students of all programs periodic training guidelines for health and occupational safety and gives knowledge of electrical hazard of given branch of study. Students receive indispensable qualification according to the current Directive of the Dean. | | | |
| 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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