# Study plan

## Name of study plan: Electronics and Communications

Faculty/Institute/Others: Faculty of Electrical Engineering
Department:
Branch of study guaranteed by the department:
Garantor of the study branch: prof. Ing. Stanislav Zvánovec, Ph.D.
Program of study: Electronics and Communications
Type of study: Follow-up master full-time
Required credits: 103
Elective courses credits: 17
Sum of credits in the plan: 120
Note on the plan:

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Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 43
The role of the block: P

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Code of the group: 2021_MEKDIP
Name of the group: Diploma Thesis
Requirement credits in the group: In this group you have to gain 25 credits
Requirement courses in the group: In this group you have to complete 1 course
Credits in the group: 25
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 |
|---|---|---|---|---|---|---|
| BDIP25 | **Diploma Thesis** | Z | 25 | 22s | L | P |

**Characteristics of the courses of this group of Study Plan: Code=2021_MEKDIP Name=Diploma Thesis**

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|---|---|---|---|
| BDIP25 | Diploma Thesis | Z | 25 |

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.

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Code of the group: 2021_MEKP8
Name of the group: Compulsory subjects of the programme
Requirement credits in the group: In this group you have to gain 18 credits
Requirement courses in the group: In this group you have to complete 3 courses
Credits in the group: 18
Note on the group: Specializace Komunikace a zpracování informace (KZI)

| 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 |
|---|---|---|---|---|---|---|
| B2M32BTSA | **Wireless Technologies** *Zdeněk Bečvář, Lukáš Vojtěch, Jan Plachý, Zbyněk Kocur* ***Lukáš Vojtěch*** *Zdeněk Bečvář (Gar.)* | Z,ZK | 6 | 2P + 2L | L | P |
| B2M37MAM | **Microprocessors** *Petr Skalický, Stanislav Vítek* ***Stanislav Vítek*** *Stanislav Vítek (Gar.)* | Z,ZK | 6 | 2P+2L | Z | P |
| B2M31DSP | **Advanced DSP methods** *Pavel Sovka, Petr Pollák* ***Pavel Sovka*** *Pavel Sovka (Gar.)* | Z,ZK | 6 | 2P+2C | Z,L | P |
| B2MPROJ6 | **Project** *Jiří Jakovenko, Pavel Máša, Ivan Pravda, František Rund, Jan Šístek, Lubor Jirásek, Tomáš Zeman, Ladislav Oppl* ***František Rund*** *František Rund (Gar.)* | Z | 6 | 0p+6s | | P |

**Characteristics of the courses of this group of Study Plan: Code=2021_MEKP8 Name=Compulsory subjects of the programme**

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|---|---|---|---|
| B2M32BTSA | Wireless Technologies | Z,ZK | 6 |

The lectures give overview of fundamental principles of wireless networks in various areas of their application. Students will understand architecture, principles and protocols used in different wireless technologies and learn how these technologies can be exploited in real world applications. The goal is to teach students how to solve problems related to deployment of wireless networks, their operation or development of wireless networks components.

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|---|---|---|---|
| B2M37MAM | Microprocessors | Z,ZK | 6 |
| The aim is to make students acquainted with the properties of microprocessor systems, make students familiar with on-chip peripherals, connect external circuit to the processor bus, and with implementation of the memory or I/O space address extension. Next, taught the students to make simple program in the assembly language, C language and combination of both. After completion of this subject student should be able to design and implement simpler microprocessor system including connection of necessary peripherals and software design. | | | |
| B2M31DSP | Advanced DSP methods | Z,ZK | 6 |
| The course follows the basic course in signal processing and introduces advanced methods of analysis and digital signal processing. Graduates will learn the methods of digital signals analysis and be able to practically use them. They learn to know the conditions of use of correlation, spectral and coherent analysis of random signals. They will became familiar with methods of signal decomposition and independent component analysis and the time-frequency transformations. Emphasis will be placed on an ability to interpret the results of signal analyses. | | | |
| B2MPROJ6 | 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. Project list http://www.fel.cvut.cz/en/education/semestral-projects.html | | | |

Name of the block: Compulsory elective courses
Minimal number of credits of the block: 60
The role of the block: PV

Code of the group: 2021_MEKPV8B
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: Specializace Komunikace a zpracování informace (KZI)

| Code | Name of the course / Name of the group of courses<br>*(in case of groups of courses the list of codes of their members)*<br>*Tutors,* ***authors*** *and guarantors (gar.)* | Completion | Credits | Scope | Semester | Role |
|---|---|---|---|---|---|---|
| B2M31ADAA | **Adaptive signal processing**<br>*Pavel Sovka, Radoslav Bortel* ***Radoslav Bortel*** *Radoslav Bortel (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| B2M37CIR | **Implementation of the digital circuits in Radio**<br>*Petr Skalický, Stanislav Vítek* ***Stanislav Vítek*** *Petr Skalický (Gar.)* | Z,ZK | 6 | 2P+2L | L | PV |
| B4M33DZO | **Digital image**<br>*Václav Hlaváč, Radoslav Škoviera* ***Václav Hlaváč*** *Václav Hlaváč (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| B2M32IBEA | **Information Security**<br>*Tomáš Vaněk* ***Petr Hampl*** *Leoš Boháč (Gar.)* | Z,ZK | 6 | 2P + 2C | L | PV |
| B3M35ORR | **Optimal and robust control**<br>*Zdeněk Hurák* ***Zdeněk Hurák*** *Zdeněk Hurák (Gar.)* | Z,ZK | 6 | 2P+2C | L | PV |
| B3M35PSR | **Real -Time Systems Programming**<br>*Michal Sojka* ***Michal Sojka*** *Michal Sojka (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| B4M33SSU | **Statistical Machine Learning** | Z,ZK | 6 | 2P+2C | Z | PV |
| B2M17SBS | **Wave Propagation for Wireless Links**<br>*Pavel Pechač* ***Pavel Pechač*** *Pavel Pechač (Gar.)* | Z,ZK | 6 | 2P+2C | L | PV |
| B2M32THOA | **Queueing Theory**<br>*Petr Hampl* ***Petr Hampl*** *Petr Hampl (Gar.)* | Z,ZK | 6 | 3P + 1L | Z | PV |
| B2M01TIK | **Information Theory and Coding**<br>*Jan Hamhalter, Alena Gollová* ***Alena Gollová*** *Jan Hamhalter (Gar.)* | Z,ZK | 6 | 3P+1C | L | PV |

**Characteristics of the courses of this group of Study Plan: Code=2021_MEKPV8B Name=Compulsory subjects of the programme**

| | | | |
|---|---|---|---|
| B2M31ADAA | Adaptive signal processing | Z,ZK | 6 |
| This course provides a basic discourse on adaptive algorithms for filtering, decorrelation, separation and beamforming. | | | |
| B2M37CIR | Implementation of the digital circuits in Radio | Z,ZK | 6 |
| The course is base for student, which want practically designed circuits of the digital signal processing with the signal processors and specialised circuits. Attention is concentration to realisation of the modulators and circuit of the numerical conversion of the signal, algoritms coding/decoding, which contains in the communication chain. Dominantly is concentration to effective realization with minimal computing power. | | | |
| B4M33DZO | Digital image | Z,ZK | 6 |
| The subject teaches how to represent the two-dimensional image in a computer, how to process it and interpret it. The first part of the subject deals with the image as with the signal without interpretation. Image acquisition, linear and nonlinear preprocessing methods and image compression will be explicated. In the second part, image segmentation and registration methods will be taught. Studied topics will be practiced on practical examples in order to obtain also practical skills. | | | |
| B2M32IBEA | Information Security | Z,ZK | 6 |
| The Information Security course provides a complete source of information on the field of security of information systems and information technologies. The most of information in today society is created, transferred, stored in electronic form so information security is very important part of it. Technical background for information security is provided by cryptology. | | | |

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| B3M35ORR | Optimal and robust control | Z,ZK | 6 |

This advanced course will be focused on design methods for optimal and robust control. Major emphasis will be put on practical computational skills and realistically complex problem assignments. The unifying concept is that of minimization of some optimization criterion. The properties of the resulting controller depend upon which criterion is minimized. Minimizing the popular integral-of-square-of criterion seeks a trade-off between a regulation error and a control effort. The modern theory introduces the concept of a system norm. Minimizing the H2 norm generalizes the classical LQ/LQG control. Minimizing the Hinf norm gives a controller which is robust (insensitive) to inaccuracies in the mathematical model of the system. The mu-synthesis is then an extension of Hinf methodology for systems with structured uncertainty. Hence robust control can be viewed as an offspring of the powerful paradigm of optimal control. The presented optimization-based control design can be solved either offline, or online. In the latter case the optimization can be done by invoking some nonlinear programming solver in every sampling period. This is the essence of model predictive control, which will be briefly introduced in this course. Also included in this course will be methods for time optimal and suboptimal control, which have already been found useful in applications with stringent timing requirements. In addition, semidefinite optimization and linear matrix inequalities will be introduced as these constitute a very flexible framework both for analysis and for numerical computation in robust control. Finally, computational methods for reduction of model and controller order will be covered in the course.

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| B3M35PSR | Real -Time Systems Programming | Z,ZK | 6 |

The goal of this course is to provide students with basic knowledge about software development for real-time systems, for example in control and embedded applications. The focus is on embedded systems equipped with a real-time operating system (RTOS). Lectures will cover real-time systems theory, which can be used to formally verify timing correctness of such systems. Another set of lectures will introduce methods and techniques used for development of safety-critical systems, whose failure may have catastrophic consequences. During labs, students will first solve a few simple tasks to familiarize themselves with basic components of VxWorks RTOS and to benchmark the used OS and hardware (Xilinx Zynq). The obtained metrics represent the typical criteria for assessing the suitability of a given platform for the given application. After the simple tasks, students will solve a complex task of time-critical motion control application which will require full utilization of RTOS features. All the tasks at the labs will be implemented in C (or C++) language.

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|---|---|---|---|
| B4M33SSU | Statistical Machine Learning | Z,ZK | 6 |

The aim of statistical machine learning is to develop systems (models and algorithms) able to learn 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.

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|---|---|---|---|
| B2M17SBS | Wave Propagation for Wireless Links | Z,ZK | 6 |

The aim of the course is to study the wireless transmission channel in real environments focusing on wave propagation for planning of terrestrial and satellite wireless links. The syllabus includes both deeper theoretical foundations of radio wave propagation in the atmosphere as well as ITU-R design procedures for terrestrial and satellite, fixed and mobile communications in various frequency bands.

| | | | |
|---|---|---|---|
| B2M32THOA | Queueing Theory | Z,ZK | 6 |

The aim of the course is to present an overview of dimensioning of telecommunication networks on the basis of results of the queuing theory (QT) and to introduce possibilities of simulation and modelling of networks, both from the point of view of grade of service (GoS) and quality of service (QoS). Results of the QT are applied on different service systems and telecommunication networks being currently operated and developed. Theoretical knowledge about models of service systems can be applied on dimensioning of different service systems in real life - not only on the telecommunications one.

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|---|---|---|---|
| B2M01TIK | Information Theory and Coding | Z,ZK | 6 |

Fundamentals of information theory with a view towards efficient data compression and reliable transmission of information.

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Code of the group: 2021_MEKPV8A
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: Specializace Komunikace a zpracování informace (KZI)

| 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 |
|---|---|---|---|---|---|---|
| B3M35DRS | **Dynamics and Control Networks** *Kristian Hengster-Movric* ***Zdeněk Hurák*** *Michael Šebek (Gar.)* | Z,ZK | 6 | 2P+2C | Z | PV |
| B2M37KDKA | **Coding in digital communications** *Jan Sýkora* ***Jan Sýkora*** *Jan Sýkora (Gar.)* | Z,ZK | 6 | 3P+1C | L | PV |
| B2M37KASA | **Compression of images and signals** *Stanislav Vítek, František Rund, Karel Fliegel, Václav Vencovský* ***Karel Fliegel*** *Stanislav Vítek (Gar.)* | Z,ZK | 6 | 2P+2C | L | PV |
| B2M32MKSA | **Mobile Networks** *Zdeněk Bečvář, Robert Bešťák, Pavel Mach* ***Pavel Mach*** *Zdeněk Bečvář (Gar.)* | Z,ZK | 6 | 2P + 2L | Z | PV |
| B2M37SEK | **Synchronization and equalization in digital communications** *Jan Sýkora* ***Jan Sýkora*** *Jan Sýkora (Gar.)* | Z,ZK | 6 | 3P+1C | Z | PV |

**Characteristics of the courses of this group of Study Plan: Code=2021_MEKPV8A Name=Compulsory subjects of the programme**

| | | | |
|---|---|---|---|
| B3M35DRS | Dynamics and Control Networks | Z,ZK | 6 |

The course offers a response to the increasing demand for understanding of networks - large-scale and complex dynamical systems that are created by interconnecting components and subsystems. We will not restrict ourselves to one physical or technological domain. Quite the opposite, we will analyze the network-related phenomena found in several domains, including societal, economic, or biological. We will analyze the fundamental similarities among flight control of formations of unmanned aerial vehicles, tigh distance regulation in platoons of trucks on highways, generation and distribution of energy in smart grids, realization of a phone call in a cellular phone network, manipulation of a community through Facebook, or even forecasting the epidemics spread over a globe. For such networks, the resulting behavior is given not only by the individual components and subsystems but also by the way in which they are interconnected (topology of the network). Understanding these issues goes far beyond the boundaries of individual physical and technological or scientific domains. In the first part of the course we will introduce fundamental theoretical and computational concepts for analysis of networks, in particular, we will introduce basics of algebraic graph theory and network algorithms. In the second half of the course we will view the network as a dynamic system and we will study its properties and the ways in which these properties can be affected (controlled). We will use the methodologies from the automatic control theory. Finally, we will introduce some interesting tools for analysis and synthesis of networked systems such as wave and scattering description and distributed optimization.

| | | | |
|---|---|---|---|
| B2M37KDKA | Coding in digital communications | Z,ZK | 6 |
| This course extends and deepens the topics of the basic communication theory courses in the following main areas. 1) Advanced information theory in coding and Network Information Theory develop a framework for understanding the principles of the channel coding in single-user and multi-node/multi-user scenarios. 2) The algebraic coding presents classical topics of block and convolutional codes. 3) Advanced coding technique focuses on turbo, LDPC, Space-Time codes and Wireless Network Coding. 4) Advanced decoding technique, namely iterative and multi-user decoding is a fundamental tool for decoding capacity approaching channel codes. | | | |
| B2M37KASA | Compression of images and signals | Z,ZK | 6 |
| The subject deals with compression methods and techniques. Main goal is to introduce basic concepts of lossless and lossy compresion of audiovisual information (entropy, redundancy and irrelevancy). Within the laboratory exercises students will work with implementations of particular algorithms, including objective and subjective methods of quality evaluation. | | | |
| B2M32MKSA | Mobile Networks | Z,ZK | 6 |
| The lectures introduce principles and functionalities of mobile networks with special focus on currently deployed technologies and future mobile networks. Furthermore, architecture and fundamental principles of GSM, UMTS, LTE and LTE-A will be explained. Then, selected key technologies for future mobile networks (e.g., 5G) will be explained. | | | |
| B2M37SEK | Synchronization and equalization in digital communications | Z,ZK | 6 |
| We explain principles of the receiver signal processing (synchronization and equalization) for the parametric channel including variety of the implementation possibilities. We focus on the essential particular forms of the channel phase, frequency and timing parameterization, channels with multipath propagation and MIMO channels. We develop the ideas of synchronization and equalization in the context of the data decoding in the parametric channel. All basic categories of the CSE algorithms are targeted: feed-forward, feed-back, iterative and recursive, including the theoretical background of the parameter estimation theory, and theory of the feed-back and iterative systems. | | | |

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

Code of the group: 2021_MEKH
Name of the group: Humanities subjects
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
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 |
|---|---|---|---|---|---|---|
| B0M16FIL | **Philosophy 2** *Peter Zamarovský* ***Peter Zamarovský*** *Peter Zamarovský (Gar.)* | Z,ZK | 5 | 2P+2S | Z,L | v |
| B0M16HVT | **History of science and technology 2** *Marcela Efmertová, Jan Mikeš* ***Marcela Efmertová*** *Marcela Efmertová (Gar.)* | Z,ZK | 5 | 2P+2S | Z,L | v |
| B0M16HSD1 | **History of economy and social studies** ***Marcela Efmertová*** | Z,ZK | 5 | 2P+2S | Z,L | v |
| B0M16PSM | **Psychology** *Jan Fiala, Josef Černohous* ***Jan Fiala*** *Jan Fiala (Gar.)* | Z,ZK | 5 | 2P+2S | Z,L | v |
| A003TV | **Physical Education** | Z | 2 | 0+2 | L,Z | v |
| B0M16TEO | **Theology** *Vladimír Slámečka* ***Vladimír Slámečka*** *Vladimír Slámečka (Gar.)* | Z,ZK | 5 | 2P+2S | Z,L | v |

**Characteristics of the courses of this group of Study Plan: Code=2021_MEKH Name=Humanities subjects**

| | | | |
|---|---|---|---|
| B0M16FIL | Philosophy 2 | Z,ZK | 5 |
| The course is oriented on the transdisciplinar aspects of philosophy, informatics, physics, mathematics and biology. | | | |
| B0M16HVT | History of science and technology 2 | Z,ZK | 5 |
| This subject traces historical developments in electrical engineering branches in the world and in the Czech Lands. Its ultimate goal is to stimulate students' interest in the history and traditions of the subject, while highlighting the developments in technical education and professional organizations, the process of shaping scientific life and the influence of technical engineers | | | |
| B0M16HSD1 | History of economy and social studies | Z,ZK | 5 |
| This subject deals with the history of the Czech society in the 19th - 21th centuries. It follows the forming of the Czech political representation, its aims and achieved results as well as the social and cultural development and coexistence of the various ethnical groups in the Czech countries. | | | |
| B0M16PSM | Psychology | Z,ZK | 5 |
| A003TV | Physical Education | Z | 2 |
| B0M16TEO | Theology | Z,ZK | 5 |
| This subject provides to students the basic orientation in christian theology and requires no special previous education. After short philosophic lecture the basic theologic disciplines are gone through. The subject is determined not only to believer students who want to know the reliable theologic grounding but also above all to ones who want to get know Christianity - religion from which graws our civilization up. | | | |

Code of the group: MTV
Name of the group: Physical education
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
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 |
|---|---|---|---|---|---|---|
| TVV | **Physical education** | Z | 0 | 0+2 | Z,L | v |
| TV-V1 | **Physical education** | Z | 1 | 0+2 | Z,L | v |
| TVV0 | **Physical education** | Z | 0 | 0+2 | Z,L | v |
| TVKZV | **Physical Education Course** | Z | 0 | 7dní | Z | v |
| TVKLV | **Physical Education Course** | Z | 0 | 7dní | L | v |

**Characteristics of the courses of this group of Study Plan: Code=MTV Name=Physical education**

| | | | |
|---|---|---|---|
| TVV | Physical education | Z | 0 |
| TV-V1 | Physical education | Z | 1 |
| TVV0 | Physical education | Z | 0 |
| TVKZV | Physical Education Course | Z | 0 |
| TVKLV | Physical Education Course | Z | 0 |

Code of the group: 2021_MEKVOL
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: ~Nabídku volitelných předmětů uspořádaných podle kateder najdete na webových stránkách http://www.fel.cvut.cz/cz/education/volitelne-predmety.html\\

## List of courses of this pass:

| Code | Name of the course | Completion | Credits |
|---|---|---|---|
| A003TV | Physical Education | Z | 2 |
| B0M16FIL | Philosophy 2 | Z,ZK | 5 |
| | The course is oriented on the transdisciplinar aspects of philosophy, informatics, physics, mathematics and biology. | | |
| B0M16HSD1 | History of economy and social studies | Z,ZK | 5 |
| | This subject deals with the history of the Czech society in the 19th - 21th centuries. It follows the forming of the Czech political representation, its aims and achieved results as well as the social and cultural development and coexistence of the various ethnical groups in the Czech countries. | | |
| B0M16HVT | History of science and technology 2 | Z,ZK | 5 |
| | This subject traces historical developments in electrical engineering branches in the world and in the Czech Lands. Its ultimate goal is to stimulate students' interest in the history and traditions of the subject, while highlighting the developments in technical education and professional organizations, the process of shaping scientific life and the influence of technical engineers | | |
| B0M16PSM | Psychology | Z,ZK | 5 |
| B0M16TEO | Theology | Z,ZK | 5 |
| | This subject provides to students the basic orientation in christian theology and requires no special previous education. After short philosophic lecture the basic theologic disciplines are gone through. The subject is determined not only to believer students who want to know the reliable theologic grounding but also above all to ones who want to get know Christianity - religion from which graws our civilization up. | | |
| B2M01TIK | Information Theory and Coding | Z,ZK | 6 |
| | Fundamentals of information theory with a view towards efficient data compression and reliable transmission of information. | | |
| B2M17SBS | Wave Propagation for Wireless Links | Z,ZK | 6 |
| | The aim of the course is to study the wireless transmission channel in real environments focusing on wave propagation for planning of terrestrial and satellite wireless links. The syllabus includes both deeper theoretical foundations of radio wave propagation in the atmosphere as well as ITU-R design procedures for terrestrial and satellite, fixed and mobile communications in various frequency bands. | | |
| B2M31ADAA | Adaptive signal processing | Z,ZK | 6 |
| | This course provides a basic discourse on adaptive algorithms for filtering, decorrelation, separation and beamforming. | | |
| B2M31DSP | Advanced DSP methods | Z,ZK | 6 |
| | The course follows the basic course in signal processing and introduces advanced methods of analysis and digital signal processing. Graduates will learn the methods of digital signals analysis and be able to practically use them. They learn to know the conditions of use of correlation, spectral and coherent analysis of random signals. They will became familiar with methods of signal decomposition and independent component analysis and the time-frequency transformations. Emphasis will be placed on an ability to interpret the results of signal analyses. | | |
| B2M32BTSA | Wireless Technologies | Z,ZK | 6 |
| | The lectures give overview of fundamental principles of wireless networks in various areas of their application. Students will understand architecture, principles and protocols used in different wireless technologies and learn how these technologies can be exploited in real world applications. The goal is to teach students how to solve problems related to deployment of wireless networks, their operation or development of wireless networks components. | | |

| | | | |
|---|---|---|---|
| B2M32IBEA | Information Security | Z,ZK | 6 |
| The Information Security course provides a complete source of information on the field of security of information systems and information technologies. The most of information in today society is created, transferred, stored in electronic form so information security is very important part of it. Technical background for information security is provided by cryptology. | | | |
| B2M32MKSA | Mobile Networks | Z,ZK | 6 |
| The lectures introduce principles and functionalities of mobile networks with special focus on currently deployed technologies and future mobile networks. Furthermore, architecture and fundamental principles of GSM, UMTS, LTE and LTE-A will be explained. Then, selected key technologies for future mobile networks (e.g., 5G) will be explained. | | | |
| B2M32THOA | Queueing Theory | Z,ZK | 6 |
| The aim of the course is to present an overview of dimensioning of telecommunication networks on the basis of results of the queuing theory (QT) and to introduce possibilities of simulation and modelling of networks, both from the point of view of grade of service (GoS) and quality of service (QoS). Results of the QT are applied on different service systems and telecommunication networks being currently operated and developed. Theoretical knowledge about models of service systems can be applied on dimensioning of different service systems in real life - not only on the telecommunications one. | | | |
| B2M37CIR | Implementation of the digital circuits in Radio | Z,ZK | 6 |
| The course is base for student, which want practically designed circuits of the digital signal processing with the signal processors and specialised circuits. Attention is concentration to realisation of the modulators and circuit of the numerical conversion of the signal, algoritms coding/decoding, which contains in the communication chain. Dominantly is concentration to effective realization with minimal computing power. | | | |
| B2M37KASA | Compression of images and signals | Z,ZK | 6 |
| The subject deals with compression methods and techniques. Main goal is to introduce basic concepts of lossless and lossy compresion of audiovisual information (entropy, redundancy and irrelevancy). Within the laboratory exercises students will work with implementations of particular algorithms, including objective and subjective methods of quality evaluation. | | | |
| B2M37KDKA | Coding in digital communications | Z,ZK | 6 |
| This course extends and deepens the topics of the basic communication theory courses in the following main areas. 1) Advanced information theory in coding and Network Information Theory develop a framework for understanding the principles of the channel coding in single-user and multi-node/multi-user scenarios. 2) The algebraic coding presents classical topics of block and convolutional codes. 3) Advanced coding technique focuses on turbo, LDPC, Space-Time codes and Wireless Network Coding. 4) Advanced decoding technique, namely iterative and multi-user decoding is a fundamental tool for decoding capacity approaching channel codes. | | | |
| B2M37MAM | Microprocessors | Z,ZK | 6 |
| The aim is to make students acquainted with the properties of microprocessor systems, make students familiar with on-chip peripherals, connect external circuit to the processor bus, and with implementation of the memory or I/O space address extension. Next, taught the students to make simple program in the assembly language, C language and combination of both. After completion of this subject student should be able to design and implement simpler microprocessor system including connection of necessary peripherals and software design. | | | |
| B2M37SEK | Synchronization and equalization in digital communications | Z,ZK | 6 |
| We explain principles of the receiver signal processing (synchronization and equalization) for the parametric channel including variety of the implementation possibilities. We focus on the essential particular forms of the channel phase, frequency and timing parameterization, channels with multipath propagation and MIMO channels. We develop the ideas of synchronization and equalization in the context of the data decoding in the parametric channel. All basic categories of the CSE algorithms are targeted: feed-forward, feed-back, iterative and recursive, including the theoretical background of the parameter estimation theory, and theory of the feed-back and iterative systems. | | | |
| B2MPROJ6 | 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. Project list http://www.fel.cvut.cz/en/education/semestral-projects.html | | | |
| B3M35DRS | Dynamics and Control Networks | Z,ZK | 6 |
| The course offers a response to the increasing demand for understanding of networks - large-scale and complex dynamical systems that are created by interconnecting components and subsystems. We will not restrict ourselves to one physical or technological domain. Quite the opposite, we will analyze the network-related phenomena found in several domains, including societal, economic, or biological. We will analyze the fundamental similarities among flight control of formations of unmanned aerial vehicles, tigh distance regulation in platoons of trucks on highways, generation and distribution of energy in smart grids, realization of a phone call in a cellular phone network, manipulation of a community through Facebook, or even forecasting the epidemics spread over a globe. For such networks, the resulting behavior is given not only by the individual components and subsystems but also by the way in which they are interconnected (topology of the network). Understanding these issues goes far beyond the boundaries of individual physical and technological or scientific domains. In the first part of the course we will introduce fundamental theoretical and computational concepts for analysis of networks, in particular, we will introduce basics of algebraic graph theory and network algorithms. In the second half of the course we will view the network as a dynamic system and we will study its properties and the ways in which these properties can be affected (controlled). We will use the methodologies from the automatic control theory. Finally, we will introduce some interesting tools for analysis and synthesis of networked systems such as wave and scattering description and distributed optimization. | | | |
| B3M35ORR | Optimal and robust control | Z,ZK | 6 |
| This advanced course will be focused on design methods for optimal and robust control. Major emphasis will be put on practical computational skills and realistically complex problem assignments. The unifying concept is that of minimization of some optimization criterion. The properties of the resulting controller depend upon which criterion is minimized. Minimizing the popular integral-of-square-of criterion seeks a trade-off between a regulation error and a control effort. The modern theory introduces the concept of a system norm. Minimizing the H2 norm generalizes the classical LQ/LQG control. Minimizing the Hinf norm gives a controller which is robust (insensitive) to inaccuracies in the mathematical model of the system. The mu-synthesis is then an extension of Hinf methodology for systems with structured uncertainty. Hence robust control can be viewed as an offspring of the powerful paradigm of optimal control. The presented optimization-based control design can be solved either offline, or online. In the latter case the optimization can be done by invoking some nonlinear programming solver in every sampling period. This is the essence of model predictive control, which will be briefly introduced in this course. Also included in this course will be methods for time optimal and suboptimal control, which have already been found useful in applications with stringent timing requirements. In addition, semidefinite optimization and linear matrix inequalities will be introduced as these constitute a very flexible framework both for analysis and for numerical computation in robust control. Finally, computational methods for reduction of model and controller order will be covered in the course. | | | |
| B3M35PSR | Real -Time Systems Programming | Z,ZK | 6 |
| The goal of this course is to provide students with basic knowledge about software development for real-time systems, for example in control and embedded applications. The focus is on embedded systems equipped with a real-time operating system (RTOS). Lectures will cover real-time systems theory, which can be used to formally verify timing correctness of such systems. Another set of lectures will introduce methods and techniques used for development of safety-critical systems, whose failure may have catastrophic consequences. During labs, students will first solve a few simple tasks to familiarize themselves with basic components of VxWorks RTOS and to benchmark the used OS and hardware (Xilinx Zynq). The obtained metrics represent the typical criteria for assessing the suitability of a given platform for the given application. After the simple tasks, students will solve a complex task of time-critical motion control application which will require full utilization of RTOS features. All the tasks at the labs will be implemented in C (or C++) language. | | | |
| B4M33DZO | Digital image | Z,ZK | 6 |
| The subject teaches how to represent the two-dimensional image in a computer, how to process it and interpret it. The first part of the subject deals with the image as with the signal without interpretation. Image acquisition, linear and nonlinear preprocessing methods and image compression will be explicated. In the second part, image segmentation and registration methods will be taught. Studied topics will be practiced on practical examples in order to obtain also practical skills. | | | |
| B4M33SSU | Statistical Machine Learning | Z,ZK | 6 |
| The aim of statistical machine learning is to develop systems (models and algorithms) able to learn 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, | | | |

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| 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. | | | |
| BDIP25 | Diploma Thesis | Z | 25 |
| 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. | | | |
| TV-V1 | Physical education | Z | 1 |
| TVKLV | Physical Education Course | Z | 0 |
| TVKZV | Physical Education Course | Z | 0 |
| TVV | Physical education | Z | 0 |
| TVV0 | Physical education | Z | 0 |

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