Study plan

Name of study plan: Master specialization Embedded systems

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Applied Informatics
Type of study: Follow-up master full-time
Required credits: 102
Elective courses credits: 18
Sum of credits in the plan: 120
Note on the plan: Garant: prof. Ing. Hana Kubátová, CSc., e-mail: hana.kubatova@fit.cvut.cz

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Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 62
The role of the block: PP

Code of the group: ANI-PP
Name of the group: Compulsory courses of the program Applied Informatics
Requirement credits in the group: In this group you have to gain 62 credits
Requirement courses in the group: In this group you have to complete 7 courses
Credits in the group: 62
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
ANI-DIP	**Diploma Thesis** ***Zdeněk Muzikář***	Z	30	270ZP	L,Z	PP
ANI-KOP	**Combinatorial Optimization** ***Petr Fišer***	Z,ZK	6	2P+2C	Z	PP
ANI-MLM	**Machine Learning Methods** ***Daniel Vašata***	Z,ZK	5	2P+1C		PP
ANI-ARC	**Advanced Computer Architecture**	Z,ZK	5	2P+1C	Z	PP
ANI-SAI	**Statistics for Applied Informatics** ***Kamil Dedecius***	Z,ZK	5	2P+1C	L	PP
ANI-TPA	**Team project A**	Z	4	3C	L	PP
ANI-TPB	**Team project B**	Z	7	4C		PP

Characteristics of the courses of this group of Study Plan: Code=ANI-PP Name=Compulsory courses of the program Applied Informatics

ANI-DIP	Diploma Thesis	Z	30
ANI-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain the knowledge and understanding necessary to judge combinatorial problems by their complexity and deployment target (on-line, multicriterial, etc.). They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems.			
ANI-MLM	Machine Learning Methods	Z,ZK	5
The course introduces students to machine learning methods applicable within their specializations in the follow-up Applied Informatics program. These principles and competencies are not part of the common undergraduate curriculum and are typically taught only in specializations focused on artificial intelligence. The aim is to understand the theoretical foundations and to gain practical experience in applying models suitable for regression and classification tasks within supervised learning, including kernel methods and neural networks. In unsupervised learning, students will become familiar primarily with clustering models and principal component analysis. The course also covers model evaluation techniques and fundamental methods for data preprocessing. Practical exercises involve data analysis and model implementation using the Python libraries pandas, scikit-learn, and PyTorch.			
ANI-ARC	Advanced Computer Architecture	Z,ZK	5
The aim of the course is to provide students with a theoretical foundation for understanding modern computer systems that run real-world applications, which is necessary for all specializations in the program. Students will learn to understand current technical challenges, typical for example of the automotive industry, with regard to fast system response to external stimuli in real time, fast and secure processing of large volumes of data, integration of artificial intelligence, ensuring the required level of reliability according to the application, and at the same time rapid development and bringing results to market. Emphasis is placed not only on choosing suitable (parallel) algorithms, but also on selecting the most appropriate technological means for their implementation.			
ANI-SAI	Statistics for Applied Informatics	Z,ZK	5

ANI-TPA	Team project A	Z	4
Team project. The graduate will gain experience in the following areas: project planning, management, and monitoring; ideation; risk analysis; and software support for teamwork. Teams are formed across specializations, so each group will also include students who will learn more details about project leadership, risk analysis, ideation, user interface design, and related topics in other courses of the program (for example, Software Product Development (ANI-TSW) or User Interface Design (ANI-NUR)). Students work on the projects independently with the support of collaboration tools. In particular, they will use GitLab Premium, which the faculty provides, and which supports a wide range of tools for managing and implementing team projects.			
ANI-TPB	Team project B	Z	7

Name of the block: Compulsory courses in the specialization
Minimal number of credits of the block: 35
The role of the block: PS

Code of the group: ANI-PS-ES
Name of the group: Compulsory Courses of Master specialization Embedded systems, program ANI
Requirement credits in the group: In this group you have to gain 35 credits
Requirement courses in the group: In this group you have to complete 7 courses
Credits in the group: 35
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
ANI-BVS	**Embedded Security** ***Martin Novotný***	Z,ZK	5	2P+2C	L	PS
ANI-BKO	**Error Control Coding** ***Pavel Kubalík***	Z,ZK	5	2P+1C	L	PS
ANI-EHW	**Embedded Hardware**	Z,ZK	5	2P+2C	L	PS
ANI-ESW	**Embedded Software** ***Miroslav Skrbek***	Z,ZK	5	2P+2C	Z	PS
ANI-SIM	**Digital Circuit Simulation and Verification**	Z,ZK	5	2P+1C	Z	PS
ANI-COM	**Network Communication**	Z,ZK	5	2P+1C		PS
ANI-TSP	**Testing and Reliability**	Z,ZK	5	2P+2C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=ANI-PS-ES Name=Compulsory Courses of Master specialization Embedded systems, program ANI

ANI-BVS	Embedded Security	Z,ZK	5
Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems.			
ANI-BKO	Error Control Coding	Z,ZK	5
The course extends the basic knowledge of error-control codes used in modern systems for error detection and correction. It presents the necessary mathematical theory and the principles of linear and cyclic codes, as well as codes for correcting multiple errors, burst errors, and whole symbols (bytes). Students will also learn how to implement these detection and correction techniques for different types of transmission (parallel and serial), when storing data in memories and when transmitting it over telecommunication channels.			
ANI-EHW	Embedded Hardware	Z,ZK	5
ANI-ESW	Embedded Software	Z,ZK	5
The course introduces students to the principles and distinctive features of software development for embedded systems. It leads students from the basics of programming in C and code optimization through key topics such as reliable software design, embedded operating systems, and signal processing, culminating in advanced methods that integrate embedded software development with artificial intelligence.			
ANI-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
The aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers recent verification methods, too.			
ANI-COM	Network Communication	Z,ZK	5
The course focuses on the technical aspects of communication between devices and systems. During the semester, topics will be presented ranging from physical layers and communication media to communication protocols and traffic monitoring. Upon completion, students will gain an understanding of the technical limitations and capabilities of communication tools that can be applied in the design and development of real hardware or software systems.			
ANI-TSP	Testing and Reliability	Z,ZK	5
Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with built-in-self-test equipment. They will be able to compute, analyze, and control the reliability and availability of the designed circuits.			

Name of the block: Elective vocational courses in the branch/specialization
Minimal number of credits of the block: 0
The role of the block: VO

Code of the group: ANI-VS-ES
Name of the group: Elective Vocational Courses for Master Specialisation Embedded systems

Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: All compulsory subjects of specializations of progr. ANI with the exception of this specialization

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
ANI-ADP	**Architectural and Design Patterns**	Z,ZK	5	2P+1C	Z	VO
ANI-AM1	**Middleware Architectures 1**	Z,ZK	5	2P+1C	L	VO
ANI-AM2	**Middleware Architectures 2**	Z,ZK	5	2P+1C		VO
ANI-DZO	**Digital Image Processing**	Z,ZK	6	2P+2C	Z	VO
ANI-DDW	**Web Data Mining**	Z,ZK	5	2P+1C	Z	VO
ANI-EGG	**Engines for Games and Graphics** ***Petr Pauš***	Z,ZK	4	1P+2C	Z	VO
ANI-MEP	**Modelling of Enterprise Processes** ***Robert Pergl***	Z,ZK	5	2P+1C	Z	VO
ANI-NUR	**User Interface Design**	Z,ZK	5	2P+1C	Z	VO
ANI-NSS	**Normalized Software Systems** ***Robert Pergl***	ZK	5	2P+1C	L	VO
ANI-PG1	**Computer Grafics 1** ***Radek Richtr***	ZK	5	2P+2C	L	VO
ANI-PIV	**Computer Vision** ***Radek Richtr***	Z,ZK	5	2P+2C	Z	VO
ANI-BUI	**Business Informatics**	Z,ZK	5	2P+2C	L	VO
ANI-PAS	**Advanced Aspects of Business**	Z,ZK	5	2P+2C	Z	VO
ANI-PDB	**Advanced Database Systems**	Z,ZK	5	2P+1C	Z	VO
ANI-ROZ	**Pattern Recognition** ***Michal Haindl***	Z,ZK	5	2P+1C	Z	VO
ANI-SWE	**Semantic Web and Knowledge Graphs**	Z,ZK	5	2P+1C	Z	VO
ANI-SEP	**World Economy and Business** ***Tomáš Evan***	Z,ZK	5	2P+1C	Z	VO
ANI-DSS	**Decision Support Systems** ***Robert Pergl***	Z,ZK	5	2P+1C	Z	VO
ANI-TSW	**Software Product Development**	Z,ZK	5	2P+2C	Z	VO
ANI-DVG	**Introduction to Discrete and Computational Geometry** ***Maria Saumell Mendiola***	Z,ZK	5	2P+1C	Z	VO
ANI-VIZ	**Visualization**	Z,ZK	6	2P+2C	L	VO
ANI-VMM	**Retrieval from Multimedia**	Z,ZK	5	2P+1C	Z	VO
ANI-EDM	**Enterprise Data Management**	Z,ZK	5	2P+1C	L	VO

Characteristics of the courses of this group of Study Plan: Code=ANI-VS-ES Name=Elective Vocational Courses for Master Specialisation Embedded systems

ANI-ADP	Architectural and Design Patterns	Z,ZK	5

The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems.

ANI-AM1	Middleware Architectures 1	Z,ZK	5

Students will become familiar with the latest trends, concepts, and middleware technologies in the context of service-oriented architectures. They will gain an overview of application protocols for implementing services, such as gRPC and REST, as well as of microservice architectures, containerization, and Kubernetes. Emphasis will be placed on performance aspects in Kubernetes, including application scaling, network communication optimization (CNI), and efficient resource utilization (CPU, RAM, limit/request).

ANI-AM2	Middleware Architectures 2	Z,ZK	5

Students will become familiar with modern web application architectures such as SPA and MPA. They will gain an overview of the asynchronous I/O model in JavaScript, network communication in the browser, and technologies such as XHR, Fetch API, SSE, WebSockets, and gRPC-Web. The course also covers web security, including Same-Origin Policy, CSRF, CORS, TLS, JWT, and OAuth2, as well as protection against attacks. Students will also learn the differences between REST and GraphQL and the principles of scaling distributed applications. The course further includes deployment and monitoring of web applications in Kubernetes using Prometheus and OpenTelemetry.

ANI-DZO	Digital Image Processing	Z,ZK	6

This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting.

ANI-DDW	Web Data Mining	Z,ZK	5
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems.			
ANI-EGG	Engines for Games and Graphics	Z,ZK	4
ANI-MEP	Modelling of Enterprise Processes	Z,ZK	5
The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions.			
ANI-NUR	User Interface Design	Z,ZK	5
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs.			
ANI-NSS	Normalized Software Systems	ZK	5
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures.			
ANI-PG1	Computer Grafics 1	ZK	5
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics.			
ANI-PIV	Computer Vision	Z,ZK	5
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing.Students will get acquainted with the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical knowledge as well as on practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, ViT), motion detection, visual expressiveness (saliency).			
ANI-BUI	Business Informatics	Z,ZK	5
The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management, and lifecycle management of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).			
ANI-PAS	Advanced Aspects of Business	Z,ZK	5
The course provides students with the knowledge and skills needed to establish and run their own business in terms of both legal and economic aspects. Students will get acquainted with the current legislation associated with the establishment of a company, business relations, protection of industrial property and electronic business. They will also get acquainted with the obligations of the entrepreneur in relation to the state, the issues of accounting and tax aspects of international trade, business and marketing models and concepts.			
ANI-PDB	Advanced Database Systems	Z,ZK	5
Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines.			
ANI-ROZ	Pattern Recognition	Z,ZK	5
The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.			
ANI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance.			
ANI-SEP	World Economy and Business	Z,ZK	5
This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.			
ANI-DSS	Decision Support Systems	Z,ZK	5
The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-oriented and knowledge-oriented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will also learn about the principles of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms.			
ANI-TSW	Software Product Development	Z,ZK	5
The course is presented in Czech.			
ANI-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The aim of the course is to introduce students to the key principles of discrete and computational geometry, which plays an important role in computer science, robotics, computer graphics and geographic information systems. The course focuses on understanding basic geometric objects, algorithms and their applications in the field of computational geometry. Fundamental concepts and used structures are gradually introduced in lectures. Students will become familiar with the theoretical foundations and effective algorithms for solving problems in these areas. Exercises are focused on practical applications of the discussed concepts, implementation of algorithms and solving computationally demanding problems.			
ANI-VIZ	Visualization	Z,ZK	6
In this course, you will get the knowledge of theoretical background for visualization and the application of visualization in real-world examples. The visualization methods are aimed at exploiting both the full power of computer technologies and the characteristics (and limits) of human perception. Well-chosen visualization method serves as an external representation, with which it is possible to quickly obtain data values or compare data. This frees up the memory and cognitive capabilities of the analyst to solve the problem that the data represents.			
ANI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines.			
ANI-EDM	Enterprise Data Management	Z,ZK	5

Name of the block: Compulsory elective courses
Minimal number of credits of the block: 5
The role of the block: PV

Code of the group: ANI-PV-ES
Name of the group: Compulsory Elective Courses for Master specialization Embedded systems, program ANI
Requirement credits in the group: In this group you have to gain at least 5 credits
Requirement courses in the group: In this group you have to complete at least 1 course
Credits in the group: 5
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
ANI-NUR	**User Interface Design**	Z,ZK	5	2P+1C	Z	PV
ANI-SIS	**Integrated Circuits Structures**	Z,ZK	5	2P+2C	Z	PV
NI-MCC	**Multicore CPU Computing** *Ivan Šimeček, Daniel Langr* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=ANI-PV-ES Name=Compulsory Elective Courses for Master specialization Embedded systems, program ANI

ANI-NUR	User Interface Design	Z,ZK	5
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs.			
ANI-SIS	Integrated Circuits Structures	Z,ZK	5
NI-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.			

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

Code of the group: ANI-V
Name of the group: Purely Elective Master Courses of program ANI, in Czech
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: In addition to the courses listed here, you can enroll as an elective any course that is offered within your study program and form of study that you did not enroll as a compulsory subject in the program/branch/specialization or a compulsory elective course.Courses of this group that a student has completed in the bachelor study at CTU cannot be re-completed.

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
FITE-IL1	**Completing a professional event** ***Zdeněk Muzikář***	Z	1			V
NI-ATH	**AlgorithmicTheories of Games** *Dušan Knop, Tomáš Valla* ***Tomáš Valla*** *Tomáš Valla (Gar.)*	Z,ZK	4	2P+2C	L	V
NI-ADM	**Data Mining Algorithms** *Rodrigo Augusto Da Silva Alves, Pavel Kordík, Daniel Vašata* ***Daniel Vašata*** *Pavel Kordík (Gar.)*	Z,ZK	5	2P+1C	L	V
NI-AIB	**Algorithms of Information Security** *Martin Jureček, Olha Jurečková* ***Martin Jureček*** *Martin Jureček (Gar.)*	Z,ZK	5	2P+1C	Z	V
NI-AFP	**Applied Functional Programming** *Robert Pergl, Marek Suchánek, Daniel Němec* ***Robert Pergl*** *Robert Pergl (Gar.)*	KZ	5	2P+1C	L	V
NI-APH	**Architecture of computer games**	Z,ZK	4	2P+1C	Z	V
NI-VGA	**Video Games Architecture** *Radek Richtr, Jan Matoušek* ***Jan Matoušek*** *Radek Richtr (Gar.)*	Z,ZK	5	2P+1C	Z	V

NI-BPS	**Wireless Computer Networks** *Alexandru Moucha, Jiří Kašpar **Alexandru Moucha** Alexandru Moucha (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-BSO	**Biosignals and Biomedical Image Processing** *Vanda Benešová **Vanda Benešová** Vanda Benešová (Gar.)*	Z,ZK	5	2P+2C		v
FIT-BIP	**Blended Intensive Programme** ***Zdeněk Muzikář** Zdeněk Muzikář (Gar.)*	Z	3		Z,L	v
NIE-BLO	**Blockchain** *Josef Gattermayer, Marek Bielik, Jakub Růžička **Josef Gattermayer** Josef Gattermayer (Gar.)*	Z,ZK	5	1P+2C	Z	v
NI-CTF	**Capture The Flag** *Jakub Bartoň, Jiří Dostál, Ladislav Marko, Vojtěch Novák **Jiří Dostál** Jiří Dostál (Gar.)*	KZ	4	3C	Z,L	v
NI-CF1	**Capture the Flag 1**	KZ	4	3C	Z	v
NI-CF2	**Capture the Flag 2** *Jakub Bartoň, Jiří Dostál, Ladislav Marko, Vojtěch Novák Jiří Dostál (Gar.)*	KZ	4	3C	L	v
NI-CAP	**Cultural and Social Anthropology** *Alena Libánská, Tomáš Houdek, Jakub Šenovský **Jakub Šenovský** Alena Libánská (Gar.)*	ZK	2	2P	Z	v
NI-DPH	**Game Design**	Z,ZK	5	2P+1C	L	v
NI-DSW	**Design Sprint** *Ondřej Brém, Michal Manda **Michal Manda** Ondřej Brém (Gar.)*	Z	2	30B	Z	v
NI-PSD	**Public Services Design** *Jan Ladin **Jan Ladin** Ondřej Brém (Gar.)*	KZ	4	1P+2C	Z,L	v
FIT-PSD	**Public Services Design** *Jan Ladin **Jan Ladin** Ondřej Brém (Gar.)*	KZ	4	1P+2C	L	v
NI-DID	**Digital drawing** *Denisa Nováčková **Denisa Nováčková** Denisa Nováčková (Gar.)*	Z	2	4C	Z,L	v
NI-DZO	**Digital Image Processing**	Z,ZK	4	2P+1C	L	v
NI-DSV	**Distributed Systems and Computing** *Pavel Tvrdík **Jan Fesl** Pavel Tvrdík (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-DDM	**Distributed Data Mining**	KZ	4	3C	L	v
NI-EPC	**Effective C++ programming** *Daniel Langr **Daniel Langr** Daniel Langr (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-PAM	**Efficient Preprocessing and Parameterized Algorithms** *Ondřej Suchý **Ondřej Suchý** Ondřej Suchý (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-EVY	**Efficient Text Pattern Matching** *Jan Holub **Jan Holub** Jan Holub (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-ESC	**Experimental Project Course** *Jan Matoušek, Ondřej Brém **Ondřej Brém** Ondřej Brém (Gar.)*	KZ	8	0P+3C	L	v
NI-GLR	**Games and reinforcement learning**	Z,ZK	4	2P+2C	L	v
NI-GEN	**Code Generators** *Petr Máj **Petr Máj** Jan Janoušek (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-GNN	**Graph Neural Networks** *Miroslav Čepek **Miroslav Čepek** Miroslav Čepek (Gar.)*	Z,ZK	4	1P+1C	L	v
NI-GAK.26	**Graph theory and combinatorics** ***Tomáš Valla***	Z,ZK	6	2P+2C	L	v
FITE-GRI	**Grid Computing** *André Sopczak, Petr Fiedler **Pavel Tvrdík** André Sopczak (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-HCM	**Mind Hacking** *Marcel Jiřina, Josef Holý **Marcel Jiřina** Marcel Jiřina (Gar.)*	ZK	5	2P+1C	Z	v
NI-HWB	**Hardware Security** *Jiří Buček **Jiří Buček** Jiří Buček (Gar.)*	Z,ZK	5	2P+2C	L	v
NI-HSC	**Side-Channel Analysis in Hardware** *Vojtěch Miškovský, Petr Socha **Petr Socha** Vojtěch Miškovský (Gar.)*	Z,ZK	4	2P+2C	Z	v
NI-HMI2	**History of Mathematics and Informatics** *Alena Šolcová **Alena Šolcová** Alena Šolcová (Gar.)*	ZK	3	2P+1C	Z	v
NI-IBE	**Information Security**	ZK	2	2P	Z	v
NI-IVS	**Intelligent embedded systems** *Miroslav Skrbek **Miroslav Skrbek** Miroslav Skrbek (Gar.)*	KZ	4	1P+3C	L	v
NI-IKM	**Internet and Classification Methods** *Martin Holeňa **Martin Holeňa** Martin Holeňa (Gar.)*	Z,ZK	4	1P+1C	L	v
NI-IAM	**Internet and Multimedia**	Z,ZK	4	2P+1C	L	v
NI-IOT	**Internet of Things**	Z,ZK	4	2P+1C	L	v
FITE-EHD	**Introduction to European Economic History** *Tomáš Evan **Tomáš Evan** Tomáš Evan (Gar.)*	Z,ZK	3	2P+1C	L	v
NI-KTH	**Combinatorial Theories of Games** *Tomáš Valla **Tomáš Valla** Tomáš Valla (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-KOD	**Data Compression** *Jan Holub **Jan Holub** Jan Holub (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-FMT	**Finite model theory**	Z,ZK	4	2P+1C	L	v

NI-CCC	**Creative Coding and Computational Art** *Radek Richtr, Ondřej Brém, Jiří Šebele, Josef Kortan* ***Josef Kortan*** *Radek Richtr (Gar.)*	KZ	4	1P+2C	Z,L	v
QNI-KKP	**Cryptology and Quantum Computing** ***Róbert Lórencz***	Z,ZK	6	2P+2C	Z	v
BQM32KOS	**Quantum optical communications and networks** *Jiří Weiss, Václav Prajzler, Jan Voves, Leoš Boháč* ***Jiří Weiss*** *Leoš Boháč (Gar.)*	Z,ZK	6	2P+2L	L	v
QNI-QC1	**Quantum Computation 1** *Marcel Jiřina, Ivo Petr* ***Marcel Jiřina*** *Marcel Jiřina (Gar.)*	Z,ZK	6	2P+2C	Z	v
QNI-QC2	**Quantum Computing 2** *Ivo Petr, Tomáš Kalvoda, Aurél Gábor Gábris* ***Aurél Gábor Gábris*** *Aurél Gábor Gábris (Gar.)*	Z,ZK	6	2P+2C	L	v
NI-KYB	**Cybernality**	ZK	5	2P	Z	v
NI-LSM2	**Statistical Modelling Lab** *Kamil Dedecius* ***Kamil Dedecius*** *Kamil Dedecius (Gar.)*	KZ	5	3C	Z,L	v
NI-LOM	**Linear Optimization and Methods** *Dušan Knop* ***Dušan Knop*** *Dušan Knop (Gar.)*	Z,ZK	5	2P+1C	Z	v
QNI-LOM	**Linear Optimization and Methods** *Dušan Knop* ***Dušan Knop*** *Dušan Knop (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-MPL	**Managerial Psychology** *Jan Fiala* ***Jan Fiala*** *Jan Fiala (Gar.)*	ZK	2	2P	Z,L	v
NI-MSI	**Mathematical Structures in Computer Science** ***Jan Starý***	Z,ZK	4	2P+1C	L	v
NI-MKY.26	**Mathematics for Cryptology** ***Róbert Lórencz***	Z,ZK	7	3P+2C	L	v
QNI-MQI	**Mathematics for Quantum Informatics** *Tomáš Kalvoda, Štěpán Starosta* ***Štěpán Starosta*** *Štěpán Starosta (Gar.)*	Z,ZK	6	2P+2C	Z	v
NI-MZI	**Mathematics for data science** ***Štěpán Starosta***	Z,ZK	4	2P+1C	L	v
ANI-MLM	**Machine Learning Methods** ***Daniel Vašata***	Z,ZK	5	2P+1C		v
FIT-ITI	**Modern IT infrastructure** *Ivan Šimeček, Jan Fesl, Tomáš Vondra* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-MOP	**Modern Object-Oriented Programming in Pharo** *Jan Blizničenko* ***Robert Pergl*** *Robert Pergl (Gar.)*	KZ	4	3C	Z	v
NI-MPS	**Modern Computer Networks** ***Jan Fesl***	Z,ZK	5	2P+2C	Z	v
NI-MMA	**Multiplatform development of mobile applications** *Rostislav Babáček, Igor Rosocha, Jan Mottl, Petr Šíma* ***Martin Půlpitel*** *Martin Půlpitel (Gar.)*	KZ	4	2P+2C	L	v
NI-NLM	**Neural Language Models** *Zdeněk Kasner* ***Zdeněk Kasner*** *Zdeněk Kasner (Gar.)*	Z	5	2P+1C	L	v
NI-NMS	**Neural Networks, Machine Learning and Randomness** *Martin Holeňa* ***Martin Holeňa*** *Martin Holeňa (Gar.)*	Z,ZK	4	1P+1C	Z	v
NI-NMU	**New media in art and design** *Zdeněk Svejkovský* ***Zdeněk Svejkovský*** *Zdeněk Svejkovský (Gar.)*	ZK	3	2P+0C	Z	v
NI-OLI	**Linux Drivers** *Miroslav Skrbek, Jaroslav Borecký* ***Jaroslav Borecký*** *Miroslav Skrbek (Gar.)*	Z,ZK	4	2P+2C	L	v
NIE-PML	**Personalized Machine Learning** *Rodrigo Augusto Da Silva Alves* ***Karel Klouda*** *Rodrigo Augusto Da Silva Alves (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-ARI	**Computer arithmetic** *Pavel Kubalík* ***Pavel Kubalík*** *Pavel Kubalík (Gar.)*	Z,ZK	4	2P+1C	Z,L	v
NI-PG1	**Computer Grafics 1** *Radek Richtr, Jakub Votrubec* ***Radek Richtr*** *Radek Richtr (Gar.)*	ZK	4	2P+1C	L	v
NI-PIV	**Computer Vision** *Radek Richtr, Vanda Benešová, Šimon Šmída* ***Radek Richtr*** *Vanda Benešová (Gar.)*	Z,ZK	5	2P+2C	Z	v
NI-EDW	**Enterprise Data Warehouse Systems** *Jakub Krejčí, Robert Kotlář* ***Jakub Krejčí*** *Magda Friedjungová (Gar.)*	Z,ZK	5	1P+1C	L	v
NI-KRY	**Advanced Cryptology** *Jiří Buček, Róbert Lórencz* ***Jiří Buček*** *Róbert Lórencz (Gar.)*	Z,ZK	5	2P+2C	Z	v
NI-PVR	**Advanced Virtual Reality** *Petr Pauš* ***Petr Pauš*** *Petr Pauš (Gar.)*	KZ	4	2P+1C	Z	v
NI-AOS	**Advanced Operating Systems**	Z,ZK	5	2P+1C	Z	v
NI-AML	**Advanced machine learning** *Rodrigo Augusto Da Silva Alves, Miroslav Čepek, Petr Šimánek, Vojtěch Rybář, Zdeněk Buk* ***Miroslav Čepek*** *Miroslav Čepek (Gar.)*	Z,ZK	5	2P + 1C	L	v
NI-IOS	**Advanced techniques in iOS applications** ***Martin Půlpitel***	KZ	4	2P+2C	L	v
NI-APT	**Advanced Program Testing** *Pierre Donat-Bouillud* ***Pierre Donat-Bouillud*** *Pierre Donat-Bouillud (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-PVS	**Advanced embedded systems** ***Miroslav Skrbek***	Z,ZK	4	2P+2C	Z	v

NI-DNP	**Advanced .NET** *David Šenkýř, Nikolas Jíša* ***David Šenkýř*** *David Šenkýř (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-PYT	**Advanced Python**	KZ	4	3C	Z	v
NIE-PDL	**Practical Deep Learning** *Martin Barus, Yauhen Babakhin* ***Karel Klouda*** *Karel Klouda (Gar.)*	KZ	5	2P+1C	Z	v
FIT-ACM1	**Programming Practices 1** ***Tomáš Valla*** *Tomáš Valla (Gar.)*	KZ	5	4C	L	v
FIT-ACM2	**Programming Practices 2** ***Tomáš Valla*** *Ondřej Suchý (Gar.)*	KZ	5	4C	Z	v
FIT-ACM3	**Programming Practices 3** ***Tomáš Valla*** *Ondřej Suchý (Gar.)*	KZ	5	4C	L	v
FIT-ACM4	**Programming Practices 4** ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	KZ	5	4C	Z	v
FIT-ACM5	**Programming Practices 5** ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	KZ	5	4C	L	v
FIT-ACM6	**Programming Practices 6** ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	KZ	5	4C	L	v
NI-GPU	**GPU Architectures and Programming** *Ivan Šimeček* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-GOL	**Programming of distributed systems in GO** *Jaroslav Kříž, Róbert Selvek* ***Jaroslav Kříž*** *Jaroslav Kříž (Gar.)*	KZ	5	0P+3C	L	v
QNI-PPS	**Programming of parallel systems** *Ivan Šimeček* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	6	2P+2C	L	v
NI-PSL	**Programming in Scala**	Z,ZK	4	2P+1C	Z	v
NI-RUB	**Programming in Ruby** *Cyril Černý* ***Cyril Černý*** *Cyril Černý (Gar.)*	KZ	4	3C	Z	v
NI-PDD	**Data Preprocessing** *Marcel Jiřina* ***Marcel Jiřina*** *Marcel Jiřina (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-REV	**Reverse Engineering** *Josef Kokeš* ***Josef Kokeš*** *Josef Kokeš (Gar.)*	Z,ZK	5	1P+2C	Z	v
NI-ROZ	**Pattern Recognition** *Michal Haindl* ***Michal Haindl*** *Michal Haindl (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-RUN	**Runtime Systems** *Filip Křikava, Filip Říha* ***Filip Křikava*** *Filip Křikava (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-SEM	**Semantics of Programming Languages**	Z,ZK	5	2P+1C	Z	v
NI-PLS4	**Programming Language Seminar** *Pierre Donat-Bouillud, Filip Křikava* ***Pierre Donat-Bouillud*** *Pierre Donat-Bouillud (Gar.)*	Z	2	0P+1C	L	v
NI-PLS3	**Programming Language Seminar** ***Pierre Donat-Bouillud***	Z	2	0P+1C	Z	v
NI-PLS2	**Programming Language Seminar** *Pierre Donat-Bouillud, Filip Křikava* ***Pierre Donat-Bouillud*** *Pierre Donat-Bouillud (Gar.)*	Z	2	0P+1C	L	v
NI-PLS1	**Programming Language Seminar** *Pierre Donat-Bouillud, Filip Křikava* ***Pierre Donat-Bouillud*** *Pierre Donat-Bouillud (Gar.)*	Z	2	0P+1C	Z	v
NI-SCE1	**Computer Engineering Seminar Master I** *Hana Kubátová* ***Miroslav Skrbek*** *Hana Kubátová (Gar.)*	Z	4	2C	L,Z	v
NI-SCE2	**Computer Engineering Seminar Master II** *Hana Kubátová* ***Hana Kubátová*** *Hana Kubátová (Gar.)*	Z	4	2C	L,Z	v
FIT-SM1	**Machine Learning Seminar 1** *Pavel Kordík, Magda Friedjungová* ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	Z	v
FIT-SM2	**Machine Learning Seminar 2** *Pavel Kordík, Magda Friedjungová* ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	L	v
FIT-SM3	**Machine Learning Seminar 3** *Pavel Kordík, Magda Friedjungová* ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	Z	v
FIT-SM4	**Machine Learning Seminar 4** *Pavel Kordík, Magda Friedjungová* ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	L	v
FIT-SM5	**Machine Learning Seminar 5** *Pavel Kordík, Magda Friedjungová* ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	Z	v
FIT-SM6	**Machine Learning Seminar 6** ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	L	v
FIT-SM7	**Machine Learning Seminar 7** ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	Z	v
FIT-SM8	**Machine Learning Seminar 8** ***Magda Friedjungová*** *Pavel Kordík (Gar.)*	Z	4	2C	L	v
NI-SZ1	**Knowledge Engineering Seminar Master I** ***Pavel Kordík*** *Magda Friedjungová (Gar.)*	Z	4	2C	L,Z	v
NI-SZ2	**Knowledge Engineering Seminar Master II** ***Pavel Kordík*** *Magda Friedjungová (Gar.)*	Z	4	2C	L,Z	v
PI-SCN	**Seminars on Digital Design** *Petr Fišer* ***Petr Fišer*** *Petr Fišer (Gar.)*	ZK	4	2P+1C	Z,L	v
NI-SIB	**Network Security** *Jiří Dostál, Martin Šutovský, Martin Holec, Simona Fornůsek* ***Simona Fornůsek*** *Jiří Dostál (Gar.)*	Z,ZK	5	2P+1C	L	v

NI-MLP	**Machine Learning in Practice** *Jan Hučín **Daniel Vašata** Daniel Vašata (Gar.)*	Z,ZK	5	2P+1C	Z	v
FIT-SEP	**World Economy and Business** *Tomáš Evan **Tomáš Evan** Tomáš Evan (Gar.)*	Z,ZK	4	2P+2C	Z	v
NI-SEP	**World Economy and Business** *Tomáš Evan **Tomáš Evan** Tomáš Evan (Gar.)*	Z,ZK	4	2P+1C	Z,L	v
NI-SYP	**Parsing and Compilers** *Jan Janoušek **Jan Janoušek** Jan Janoušek (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-SBF	**System Security and Forensics** *Simona Fornůsek, Marián Svetlík, David Pokorný **Simona Fornůsek** Simona Fornůsek (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-TVR	**Virtual Reality Technology** *Tomáš Nováček **Tomáš Nováček** Tomáš Nováček (Gar.)*	Z,ZK	3	1P+1C	L,Z	v
NI-TS1	**Theoretical Seminar Master I** *Dušan Knop, Tomáš Valla, Ondřej Suchý, Michal Opler **Tomáš Valla** Tomáš Valla (Gar.)*	Z	4	2C	Z	v
NI-TS2	**Theoretical Seminar Master II** *Tomáš Valla, Ondřej Suchý **Tomáš Valla** Tomáš Valla (Gar.)*	Z	4	2C	L	v
NI-TS3	**Theoretical Seminar Master III** ***Tomáš Valla***	Z	4	2C	Z	v
NI-TS4	**Theoretical Seminar Master IV** *Tomáš Valla, Ondřej Suchý **Tomáš Valla** Ondřej Suchý (Gar.)*	Z	4	2C	L	v
QNI-TIN	**Information Theory** *Michal Kupsa, Pavel Hrabák **Pavel Hrabák** Pavel Hrabák (Gar.)*	Z,ZK	6	2P+2C	L	v
NI-TKA	**Category Theory** *Jan Starý **Jan Starý** Jan Starý (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-TNN	**Theory of Neural Networks** ***Martin Holeňa***	Z,ZK	5	2P+1C	L	v
NI-TNN.25	**Theory of Neural Networks** *Martin Holeňa **Martin Holeňa** Martin Holeňa (Gar.)*	Z,ZK	4	1P+1C	L	v
NI-CPX	**Complexity Theory** *Ondřej Suchý **Dušan Knop** Ondřej Suchý (Gar.)*	Z,ZK	5	3P+1C	Z	v
QNI-CPX	**Complexity Theory** *Dušan Knop, Ondřej Suchý **Dušan Knop** Dušan Knop (Gar.)*	Z,ZK	6	3P+1C	Z	v
NI-CPX.26	**Complexity Theory** ***Dušan Knop***	Z,ZK	6	3P+1C	Z	v
FIT-TOP	**Academic writing** *Tomáš Nováček, Petr Kroha **Tomáš Nováček** Tomáš Nováček (Gar.)*	Z	2	10B	Z	v
NI-UMI.26	**Artificial intelligence**	Z,ZK	6	2P+2C	Z	v
NI-DVG	**Introduction to Discrete and Computational Geometry** *Maria Saumell Mendiola **Maria Saumell Mendiola** Maria Saumell Mendiola (Gar.)*	Z,ZK	5	2P+1C	L	v
QNI-UKT	**Introduction to Quantum Theory** *Martin Štefaňák **Martin Štefaňák** Martin Štefaňák (Gar.)*	Z,ZK	6	2P+2C	Z	v
NI-LNG	**Introduction to Linguistics for IT Students** *Václav Cvrček **Václav Cvrček** Václav Cvrček (Gar.)*	ZK	2	2P	L	v
NI-VEM	**Scientific thinking** *Tomáš Houdek, Petr Klán, Helena Štorchová **Petr Klán** Petr Klán (Gar.)*	KZ	2	1P+1C	L	v
NI-VCC	**Virtualization and Cloud Computing** *Jan Fesl, Tomáš Vondra **Tomáš Vondra** Tomáš Vondra (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-VOL	**Elections** *Dušan Knop **Dušan Knop** Dušan Knop (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-APR	**Selected Methods for Program Analysis** *Filip Křikava **Filip Křikava** Filip Křikava (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-PON	**Selected Topics in Optimization and Numerical mathematics** *Daniel Vašata, Štěpán Starosta, Karel Klouda **Daniel Vašata** Štěpán Starosta (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-VYC	**Computability** *Jan Starý **Jan Starý** Jan Starý (Gar.)*	Z,ZK	4	2P+2C	L	v
NI-MCC	**Multicore CPU Computing** *Ivan Šimeček, Daniel Langr **Ivan Šimeček** Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-VPR	**Research Project** *Štěpán Starosta **Štěpán Starosta** Štěpán Starosta (Gar.)*	Z	5		Z,L	v

Characteristics of the courses of this group of Study Plan: Code=ANI-V Name=Purely Elective Master Courses of program ANI, in Czech

ANI-MLM	Machine Learning Methods	Z,ZK	5

The course introduces students to machine learning methods applicable within their specializations in the follow-up Applied Informatics program. These principles and competencies are not part of the common undergraduate curriculum and are typically taught only in specializations focused on artificial intelligence. The aim is to understand the theoretical foundations and to gain practical experience in applying models suitable for regression and classification tasks within supervised learning, including kernel methods and neural networks. In unsupervised learning, students will become familiar primarily with clustering models and principal component analysis. The course also covers model evaluation techniques and fundamental methods for data preprocessing. Practical exercises involve data analysis and model implementation using the Python libraries pandas, scikit-learn, and PyTorch.

NI-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.			
FITE-IL1	Completing a professional event	Z	1
The subject is participation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafting a report, etc.Such an event must be approved in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT through a website, infomail, etc.			
NI-ATH	AlgorithmicTheories of Games	Z,ZK	4
Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation.			
NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods).			
NI-AIB	Algorithms of Information Security	Z,ZK	5
Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.			
NI-AFP	Applied Functional Programming	KZ	5
This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice.			
NI-APH	Architecture of computer games	Z,ZK	4
Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also from design and philosophical perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base components that form an integral part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important part of the course is an implementation of a simple game, with a strong focus on nontrivial game mechanics.			
NI-VGA	Video Games Architecture	Z,ZK	5
The course covers a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of view, but also from a design and philosophical point of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and functional architecture typical of game development, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, including ways of implementing some game mechanics, in the form of practical demonstrations.			
NI-BPS	Wireless Computer Networks	Z,ZK	4
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.			
NI-BSO	Biosignals and Biomedical Image Processing	Z,ZK	5
The aim of the course is to provide students with theoretical principles, techniques, and applications related to the processing and analysis of biological signals and medical images. During the course, students will work on examples of processing various biosignals in the MATLAB environment. After completing the course, students should be able to design and implement solutions to complex tasks for biosignals and biomedical images, interpret results, and apply their knowledge to real-world medical challenges.			
FIT-BIP	Blended Intensive Programme	Z	3
NIE-BLO	Blockchain	Z,ZK	5
Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platforms. They will be able to design, code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places an increased emphasis on the relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the students for implementing or supervising implementation of blockchain-based solutions in both academia and business.			
NI-CTF	Capture The Flag	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.			
NI-CF1	Capture the Flag 1	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.			
NI-CF2	Capture the Flag 2	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.			
NI-CAP	Cultural and Social Anthropology	ZK	2
The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is presented in Czech.			
NI-DPH	Game Design	Z,ZK	5
The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game design. It is intended for people interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics design, storytelling, and game development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semestral projects.			
NI-DSW	Design Sprint	Z	2
Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation).			
NI-PSD	Public Services Design	KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients.			

FIT-PSD	Public Services Design	KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients.			
NI-DID	Digital drawing	Z	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color theory, which they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course is fit for anyone who wants to practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge.			
NI-DZO	Digital Image Processing	Z,ZK	4
This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting.			
NI-DSV	Distributed Systems and Computing	Z,ZK	5
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communication channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that support high availability of both data and services, and safety in case of failures.			
NI-DDM	Distributed Data Mining	KZ	4
Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands on experience with large scale data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations and will be capable to propose approaches to parallelize other algorithms. The course is prezented in czech language.			
NI-EPC	Effective C++ programming	Z,ZK	5
Students learn how to use the modern features of contemporary versions of the C++ programming language for software development. The course focuses on programming effectivity and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time requirements.			
NI-PAM	Efficient Preprocessing and Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.			
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access time and memory complexity. They will be able to use the knowledge in design of applications that utilize pattern matching.			
NI-ESC	Experimental Project Course	KZ	8
"The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, methodologies, and tools used in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design projects, collaborate with industry experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills in user-centered design and user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."			
NI-GLR	Games and reinforcement learning	Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligence. This course is intended to give you both theoretical and practical background so you can participate in related research activities. Presented in English.			
NI-GEN	Code Generators	Z,ZK	5
Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of systems programming. This primarily involves understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming. Students will become familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.			
NI-GNN	Graph Neural Networks	Z,ZK	4
The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural networks for creating vector representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last part of the course also covers graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.			
NI-GAK.26	Graph theory and combinatorics	Z,ZK	6
The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The emphasis will be not only on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topics from graph and hypergraph coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be also applied in the fields of combinatorics on words, formal languages and bioinformatics.			
FITE-GRI	Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.			
NI-HCM	Mind Hacking	ZK	5
Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, information systems and assets, the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive security is growing in importance in the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet environment have real societal impacts such as disruption of social cohesion, threats to democracy or war.			
NI-HWB	Hardware Security	Z,ZK	5
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer.			
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get familiar with various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with higher-order attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage.			

NI-HMI2	History of Mathematics and Informatics	ZK	3
This course is presented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms, transformations, recursive functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development.			
NI-IBE	Information Security	ZK	2
Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international standards in this area. They understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., penetration testing).			
NI-IVS	Intelligent embedded systems	KZ	4
Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The course is an advance version of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programming and advance application development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students develop advanced applications combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies			
NI-IKM	Internet and Classification Methods	Z,ZK	4
In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering, in recommendation systems, in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving these four kinds of problems. On the background of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle with 2-hour lectures and 2-hour exercises. During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult their semester tasks.			
NI-IAM	Internet and Multimedia	Z,ZK	4
The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquisition of AV signals (input), presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical use case scenarios of real-time audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation for audience.			
NI-IOT	Internet of Things	Z,ZK	4
The subject is focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is familiarization with available development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (GNU Forth).			
FITE-EHD	Introduction to European Economic History	Z,ZK	3
The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion.			
NI-KTH	Combinatorial Theories of Games	Z,ZK	4
Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics.			
NI-KOD	Data Compression	Z,ZK	5
Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data compression methods being used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, students learn the fundamentals of lossy data compression methods used in image, audio, and video compression.			
NI-FMT	Finite model theory	Z,ZK	4
The aim of the course is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of logical properties of database systems. Since its inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as descriptive complexity theory, the Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.			
NI-CCC	Creative Coding and Computational Art	KZ	4
Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL).			
QNI-KKP	Cryptology and Quantum Computing	Z,ZK	6
The course covers methods and algorithms of cryptology and their relation to quantum computing. In the first introductory lectures, students will be introduced to the basic principles and algorithms of cryptography. Following these topics, students will be introduced to basic cryptanalytic methods. Then some cryptanalytic algorithms running on quantum computers will be presented. In this context, the problem of security of related cryptographic schemes will be discussed. The next lectures will be devoted to post-quantum algorithms. The last lectures deal with cryptosystems using quantum phenomena.			
BQM32KOS	Quantum optical communications and networks	Z,ZK	6
TThe goal of this course is to provide a comprehensive engineering insight into optical communications, with a specific focus on Quantum Key Distribution (QKD). The subject breaks down boundaries between traditional disciplines, integrating knowledge of wave optics, hardware architecture, and network security. Students will learn to perceive the communication system as a holistic entity, where the physical layer directly defines the limits and capabilities of digital security. The course prepares students for the real-world challenges associated with deploying quantum technologies into existing telecommunications infrastructure.			
QNI-QC1	Quantum Computation 1	Z,ZK	6
The course introduces the student to basic principles of quantum computation and shows the difference between classical and quantum mechanics. Quantum computation uses quantum circuits, which will be demonstrated in the Qiskit SDK. The course will gradually introduce the student to such concepts the state of a quantum system and its visualization, measurements, basic gates and their composition, and the so-called entanglement. The student will be introduced to the BB84 and E91 protocols as demonstrations of the properties of quantum states. The course will also cover quantum teleportation, quantum oracle queries, the Deutsch-Jozsa algorithm, the quantum Fourier transform, the phase estimation algorithm, and the Shor algorithm.			
QNI-QC2	Quantum Computing 2	Z,ZK	6
Quantum Computing 2 focuses on advanced quantum algorithms and their implementations: the Grover algorithm and its applications, quantum algorithms solving linear algebra problems, HHL for solving systems of linear equations. In the course we also introduce students to variational methods and error correction.			

NI-KYB	Cybernality	ZK	5
Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams).			
NI-LSM2	Statistical Modelling Lab	KZ	5
The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clutter, or video tracking. We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters.			
NI-LOM	Linear Optimization and Methods	Z,ZK	5
Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming.			
QNI-LOM	Linear Optimization and Methods	Z,ZK	5
Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming.			
NI-MPL	Managerial Psychology	ZK	2
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical semantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scott model of lambda calculus. Introduction to category theory.			
NI-MKY.26	Mathematics for Cryptology	Z,ZK	7
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course focuses on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete logarithm. The problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.			
QNI-MQI	Mathematics for Quantum Informatics	Z,ZK	6
Linear algebra on finite dimensional spaces with scalar product, Hilbert spaces, Dirac's bra-ket formalism, normal, Hermitian and unitary operators, operator spectrum, orthonormalization, diagonalization, matrix exponential, tensor product of vector spaces and operators. Discrete Fourier transform and fast Fourier transform.			
NI-MZI	Mathematics for data science	Z,ZK	4
In this course, students are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in data science. The studied topics include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle, gradient methods) and selected notions from probability theory and statistics.			
FIT-ITI	Modern IT infrastructure	Z,ZK	5
with a very limited and time-invariable range of software or hardware, this subject tries to explain the issue as a whole and in the context of the time. A modern data or computing center is understood here as a complex whole, the individual parts of which must be reconciled from different aspects of the view using current technologies. The proposed solution should thus be capable of continuous and economically optimal operation.			
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
Object-oriented programming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where its ability to natural abstraction is used to build complex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills of design and implementation of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development needs and areas of interest. In addition to deepening object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work on interesting projects and OO technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvement in the Pharo Consortium.			
NI-MPS	Modern Computer Networks	Z,ZK	5
NI-MMA	Multiplatform development of mobile applications	KZ	4
The course introduces students to a modern approach to native mobile app development for iOS and Android using cutting-edge technologies. Emphasis is placed on sharing code for business logic, the data layer, and network communication. Students will learn to structure projects effectively, access the native APIs of both platforms from the shared codebase, and solve common as well as advanced problems in multiplatform development. The lectures will feature concrete methodologies and practice-oriented case studies from industry professionals.			
NI-NLM	Neural Language Models	Z	5
In this course, students will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The goal of the course is to teach students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific literature.			
NI-NMS	Neural Networks, Machine Learning and Randomness	Z,ZK	4
Stochastic methods, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a number of other machine learning models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks that rely substantially on randomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general stochastic approach to training neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including neural networks, are used in one of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms.			
NI-NMU	New media in art and design	ZK	3
The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game and sound. The main goal is to familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially in lectures devoted to specific art projects.			
NI-OLI	Linux Drivers	Z,ZK	4
The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining powerful processors and FPGAs increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development for master's students. The course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical experience.			
NIE-PML	Personalized Machine Learning	Z,ZK	5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.			

NI-ARI	Computer arithmetic	Z,ZK	4
Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.			
NI-PG1	Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics.			
NI-PIV	Computer Vision	Z,ZK	5
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing.Students will get acquainted with the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical knowledge as well as on practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, ViT), motion detection, visual expressiveness (saliency).			
NI-EDW	Enterprise Data Warehouse Systems	Z,ZK	5
The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowledge not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the area of reporting and data visualization.			
NI-KRY	Advanced Cryptology	Z,ZK	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions.			
NI-PVR	Advanced Virtual Reality	KZ	4
The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D models in Blender, and among other things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also deal with creating applications in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the knowledge gained in this subject in virtual reality, or directly create a complex game for VR.			
NI-AOS	Advanced Operating Systems	Z,ZK	5
The course focuses on system programming in Unix-like operating systems, with an emphasis on OS kernel development and advanced technologies for Unix system administration. Students will learn about the architecture and data structures of the OS kernel, process and memory management, the internal architecture of modern file systems, implementations of device control and network communication methods, kernel and OS booting techniques, as well as kernel debugging using dynamic instrumentation. They will also gain knowledge of kernel development and modification processes, ensuring kernel portability, and the use of containerization and virtualization technologies. Additionally, students will become familiar with the specifics of kernel implementation for embedded systems and real-time systems. Theoretical and general principles will be demonstrated primarily using the Linux kernel. The tutorials will focus on developing Linux kernel modules and using tools for managing the discussed technologies.			
NI-AML	Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of recommendation systems, image processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed.			
NI-IOS	Advanced techniques in iOS applications	KZ	4
Students will learn the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the basics from the beginners class BI-IOS.			
NI-APT	Advanced Program Testing	Z,ZK	5
Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.			
NI-PVS	Advanced embedded systems	Z,ZK	4
The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced topics like security support, working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical experiences with embedded systems.			
NI-DNP	Advanced .NET	Z,ZK	4
Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WPF, UWP), Blazor and also will get notions of Azure DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing technologies ASP.NET Core, Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.			
NI-PYT	Advanced Python	KZ	4
The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python (BI-PYT) left of. The course is very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework. The course is lead by external teachers from Red Hat.			
NIE-PDL	Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing.			
FIT-ACM1	Programming Practices 1	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM2	Programming Practices 2	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM3	Programming Practices 3	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM4	Programming Practices 4	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM5	Programming Practices 5	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM6	Programming Practices 6	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
NI-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUDA programming environment, which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational structures, students will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.			

NI-GOL	Programming of distributed systems in GO	KZ	5
QNI-PPS	Programming of parallel systems	Z,ZK	6

Nowadays, multi-core processors and GPU accelerators have become common components of computing clusters and high-performance computing systems, so knowledge and skills related to parallel programming are essential for every computer scientist. The aim of this course is to introduce students to the architectures and programming methods of parallel computers with shared memory, GPU accelerators, or with distributed memory. To effectively use these modern computing systems, it is essential to combine parallelization techniques at all three levels. Students will gain knowledge of the relevant programming models, languages and environments. They will become familiar with fundamental parallel algorithms and be able to analyze the limitations, efficiency, and scalability of parallel solutions to selected problems on high-performance computing systems. In addition to the necessary theory in lectures, students will gain practical experience and skills in programming in OpenMP, CUDA and MPI environments.

NI-PSL	Programming in Scala	Z,ZK	4

The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g.pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra, Scalaz, etc.

NI-RUB	Programming in Ruby	KZ	4

This course is presented in Czech.

NI-PDD	Data Preprocessing	Z,ZK	5

Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteristics from images or from web pages.

NI-REV	Reverse Engineering	Z,ZK	5

Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens before and after the main function is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedicated to reverse engineering of applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be dedicated to debuggers: how debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer malware scene. The focus of the course is on the seminars, where students will solve practically oriented tasks from the real world.

NI-ROZ	Pattern Recognition	Z,ZK	5

The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.

NI-RUN	Runtime Systems	Z,ZK	5

This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience in design and implementation of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compilation Memory management Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementations of real-world VMs, including Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs

NI-SEM	Semantics of Programming Languages	Z,ZK	5

The aim of the course is to introduce students to the basics of programming language semantics, which forms the foundation for the study and implementation of programming languages. These techniques are also important for program verification, the implementation of optimizations, and the general design of programming languages. The emphasis will be on comparing operational and denotational semantics. The techniques used are also applicable when analysing languages specified only by an operational semantics. The course will enable students to acquire the skills needed to implement language constructs, regardless of whether their description comes from theoretical or engineering sources in the literature.

NI-PLS4	Programming Language Seminar	Z	2

The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.

NI-PLS3	Programming Language Seminar	Z	2

The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.

NI-PLS2	Programming Language Seminar	Z	2

The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.

NI-PLS1	Programming Language Seminar	Z	2

The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.

NI-SCE1	Computer Engineering Seminar Master I	Z	4

The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in KČN laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester.

NI-SCE2	Computer Engineering Seminar Master II	Z	4

The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in KČN laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester.

FIT-SM1	Machine Learning Seminar 1	Z	4

This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).

FIT-SM2	Machine Learning Seminar 2	Z	4

This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).

FIT-SM3	Machine Learning Seminar 3	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM4	Machine Learning Seminar 4	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM5	Machine Learning Seminar 5	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM6	Machine Learning Seminar 6	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM7	Machine Learning Seminar 7	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM8	Machine Learning Seminar 8	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
PI-SCN	Seminars on Digital Design	ZK	4
This subject deals with problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description of digital circuits and basic logic synthesis and optimization algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial problems emerging in EDA.			
NI-SIB	Network Security	Z,ZK	5
NI-MLP	Machine Learning in Practice	Z,ZK	5
Applying machine learning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ideally, technical implementation. The course guides students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically. The aim is to experience real data processing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and understandable report.			
FIT-SEP	World Economy and Business	Z,ZK	4
This course is presented in Czech. The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.			
NI-SEP	World Economy and Business	Z,ZK	4
This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.			
NI-SYP	Parsing and Compilers	Z,ZK	5
The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.			
NI-SBF	System Security and Forensics	Z,ZK	5
Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication concepts). Furthermore, students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic analysis techniques and the importance of operating system/operating system artifacts or file system for attack analysis and detection).			
NI-TVR	Virtual Reality Technology	Z,ZK	3
Students will be introduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD, ...) and the possibilities of controlling virtual avatars (position tracking, hand tracking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of using virtual and augmented reality will be presented.			
NI-TS1	Theoretical Seminar Master I	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			

NI-TS2	Theoretical Seminar Master II	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
NI-TS3	Theoretical Seminar Master III	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
NI-TS4	Theoretical Seminar Master IV	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
QNI-TIN	Information Theory	Z,ZK	6
The course focuses on the mathematical description of a random message source, its coding and transmission of the source through a noisy channel. The coding problem is addressed probabilistically, the relation of the mean length of the optimal code with the entropy and entropy rate of the random source is emphasized. In the case of the noisy channel we focus on the set of typical sequences and its appropriate coding by self-correcting codes. The course includes a reminder of necessary concepts such as conditional distributions, goodness-of-fit and independence tests, and an introduction to random chains.			
NI-TKA	Category Theory	Z,ZK	4
NI-TNN	Theory of Neural Networks	Z,ZK	5
Artificial neural networks are now the foundation of artificial intelligence and the fastest-growing area of machine learning. This course introduces their theoretical foundations. It begins with general conceptsstructure, active dynamics, and adaptive dynamics (i.e., learning). Then it covers the theoretical basis of the most common types of artificial neural networks, from the perceptron of the 1950s to the transformer of 2017. Finally, using function approximation theory, it rigorously explains the most important theoretical result: the universal approximation capability of neural networks.			
NI-TNN.25	Theory of Neural Networks	Z,ZK	4
Artificial neural networks are now the foundation of artificial intelligence and the fastest-growing area of machine learning. This course introduces their theoretical foundations. It begins with general conceptsstructure, active dynamics, and adaptive dynamics (i.e., learning). Then it covers the theoretical basis of the most common types of artificial neural networks, from the perceptron of the 1950s to the transformer of 2017. Finally, using function approximation theory, it rigorously explains the most important theoretical result: the universal approximation capability of neural networks.			
NI-CPX	Complexity Theory	Z,ZK	5
Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.			
QNI-CPX	Complexity Theory	Z,ZK	6
Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.			
NI-CPX.26	Complexity Theory	Z,ZK	6
Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.			
FIT-TOP	Academic writing	Z	2
Publishing is an important and required part of research activity. It is not only about obtaining research results but also about applying them in the form of a publication. Writing scientific publications can be useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the course, students will learn how to write a scientific article, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an article and reviewing someone else's article. The course will be taught in blocks, with a theoretical part at the beginning of the semester and one practical during the exam period. Dates will be determined based on the availability of enrolled students.			
NI-UMI.26	Artificial intelligence	Z,ZK	6
The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated.			
NI-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component.			
QNI-UKT	Introduction to Quantum Theory	Z,ZK	6
interpretation of quantum theory are explained using simple models mainly from finite-dimensional quantum mechanics. Emphasis is placed on further applications of quantum theory to information processing and communication. Possible physical realizations of a qubit, description of multipartite systems, quantum entanglement and its applications are discussed. The course concludes with a description of continuous quantum systems in infinite-dimensional Hilbert spaces, in particular the linear harmonic oscillator as a description of the mode of a quantized electromagnetic field.			
NI-LNG	Introduction to Linguistics for IT Students	ZK	2
This one-semester course should provide a gentle introduction to linguistics and language research for students majoring in IT and programming. Students get acquainted with basic concepts used in language descriptions as well as major theories influencing the current mainstream in linguistics. Specific attention will be paid to empirical and quantitative methods in linguistics, including the use of language corpora, and to specific issues of Czech.			
NI-VEM	Scientific thinking	KZ	2
The objective of the course is to get acquainted with scientific methods and discovery of order and laws of the universe, including the aspects of human life. The subject combines scientific methods in natural sciences, mathematics, computer science and humanities. Another aim is to introduce rules and requirements of scientific communication via research papers and posters.			
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development).			
NI-VOL	Elections	Z,ZK	5
We will cover the basics of (committee) elections and, in general, opinion aggregation.			

NI-APR	Selected Methods for Program Analysis	Z,ZK	5
This course introduces you to program analysisthe automated reasoning about the behavior of computer programs. We will cover both static and dynamic analysis. In static analysis, we explore the art of reasoning about programs without executing them, including techniques for program understanding, optimization, and error detection. In dynamic analysis, we examine individual program executions within specific environments and inputs.			
NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too.			
NI-VYC	Computability	Z,ZK	4
Classical theory of recursive functions and effective computability.			
NI-VPR	Research Project	Z	5
Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
ANI-ADP	Architectural and Design Patterns	Z,ZK	5
The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems.			
ANI-AM1	Middleware Architectures 1	Z,ZK	5
Students will become familiar with the latest trends, concepts, and middleware technologies in the context of service-oriented architectures. They will gain an overview of application protocols for implementing services, such as gRPC and REST, as well as of microservice architectures, containerization, and Kubernetes. Emphasis will be placed on performance aspects in Kubernetes, including application scaling, network communication optimization (CNI), and efficient resource utilization (CPU, RAM, limit/request).			
ANI-AM2	Middleware Architectures 2	Z,ZK	5
Students will become familiar with modern web application architectures such as SPA and MPA. They will gain an overview of the asynchronous I/O model in JavaScript, network communication in the browser, and technologies such as XHR, Fetch API, SSE, WebSockets, and gRPC-Web. The course also covers web security, including Same-Origin Policy, CSRF, CORS, TLS, JWT, and OAuth2, as well as protection against attacks. Students will also learn the differences between REST and GraphQL and the principles of scaling distributed applications. The course further includes deployment and monitoring of web applications in Kubernetes using Prometheus and OpenTelemetry.			
ANI-ARC	Advanced Computer Architecture	Z,ZK	5
The aim of the course is to provide students with a theoretical foundation for understanding modern computer systems that run real-world applications, which is necessary for all specializations in the program. Students will learn to understand current technical challenges, typical for example of the automotive industry, with regard to fast system response to external stimuli in real time, fast and secure processing of large volumes of data, integration of artificial intelligence, ensuring the required level of reliability according to the application, and at the same time rapid development and bringing results to market. Emphasis is placed not only on choosing suitable (parallel) algorithms, but also on selecting the most appropriate technological means for their implementation.			
ANI-BKO	Error Control Coding	Z,ZK	5
The course extends the basic knowledge of error-control codes used in modern systems for error detection and correction. It presents the necessary mathematical theory and the principles of linear and cyclic codes, as well as codes for correcting multiple errors, burst errors, and whole symbols (bytes). Students will also learn how to implement these detection and correction techniques for different types of transmission (parallel and serial), when storing data in memories and when transmitting it over telecommunication channels.			
ANI-BUI	Business Informatics	Z,ZK	5
The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management, and lifecycle management of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).			
ANI-BVS	Embedded Security	Z,ZK	5
Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems.			
ANI-COM	Network Communication	Z,ZK	5
The course focuses on the technical aspects of communication between devices and systems. During the semester, topics will be presented ranging from physical layers and communication media to communication protocols and traffic monitoring. Upon completion, students will gain an understanding of the technical limitations and capabilities of communication tools that can be applied in the design and development of real hardware or software systems.			
ANI-DDW	Web Data Mining	Z,ZK	5
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems.			
ANI-DIP	Diploma Thesis	Z	30
ANI-DSS	Decision Support Systems	Z,ZK	5
The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-oriented and knowledge-oriented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will also learn about the principles of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms.			
ANI-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The aim of the course is to introduce students to the key principles of discrete and computational geometry, which plays an important role in computer science, robotics, computer graphics and geographic information systems. The course focuses on understanding basic geometric objects, algorithms and their applications in the field of computational geometry.			

	Fundamental concepts and used structures are gradually introduced in lectures. Students will become familiar with the theoretical foundations and effective algorithms for solving problems in these areas. Exercises are focused on practical applications of the discussed concepts, implementation of algorithms and solving computationally demanding problems.		
ANI-DZO	Digital Image Processing	Z,ZK	6
	This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting.		
ANI-EDM	Enterprise Data Management	Z,ZK	5
ANI-EGG	Engines for Games and Graphics	Z,ZK	4
ANI-EHW	Embedded Hardware	Z,ZK	5
ANI-ESW	Embedded Software	Z,ZK	5
	The course introduces students to the principles and distinctive features of software development for embedded systems. It leads students from the basics of programming in C and code optimization through key topics such as reliable software design, embedded operating systems, and signal processing, culminating in advanced methods that integrate embedded software development with artificial intelligence.		
ANI-KOP	Combinatorial Optimization	Z,ZK	6
	The students will gain the knowledge and understanding necessary to judge combinatorial problems by their complexity and deployment target (on-line, multicriterial, etc.). They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems.		
ANI-MEP	Modelling of Enterprise Processes	Z,ZK	5
	The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions.		
ANI-MLM	Machine Learning Methods	Z,ZK	5
	The course introduces students to machine learning methods applicable within their specializations in the follow-up Applied Informatics program. These principles and competencies are not part of the common undergraduate curriculum and are typically taught only in specializations focused on artificial intelligence. The aim is to understand the theoretical foundations and to gain practical experience in applying models suitable for regression and classification tasks within supervised learning, including kernel methods and neural networks. In unsupervised learning, students will become familiar primarily with clustering models and principal component analysis. The course also covers model evaluation techniques and fundamental methods for data preprocessing. Practical exercises involve data analysis and model implementation using the Python libraries pandas, scikit-learn, and PyTorch.		
ANI-NSS	Normalized Software Systems	ZK	5
	Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures.		
ANI-NUR	User Interface Design	Z,ZK	5
	Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs.		
ANI-PAS	Advanced Aspects of Business	Z,ZK	5
	The course provides students with the knowledge and skills needed to establish and run their own business in terms of both legal and economic aspects. Students will get acquainted with the current legislation associated with the establishment of a company, business relations, protection of industrial property and electronic business. They will also get acquainted with the obligations of the entrepreneur in relation to the state, the issues of accounting and tax aspects of international trade, business and marketing models and concepts.		
ANI-PDB	Advanced Database Systems	Z,ZK	5
	Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines.		
ANI-PG1	Computer Grafics 1	ZK	5
	The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics.		
ANI-PIV	Computer Vision	Z,ZK	5
	The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing.Students will get acquainted with the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical knowledge as well as on practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, ViT), motion detection, visual expressiveness (saliency).		
ANI-ROZ	Pattern Recognition	Z,ZK	5
	The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.		
ANI-SAI	Statistics for Applied Informatics	Z,ZK	5
ANI-SEP	World Economy and Business	Z,ZK	5
	This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.		
ANI-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
	The aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers recent verification methods, too.		
ANI-SIS	Integrated Circuits Structures	Z,ZK	5
ANI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
	The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance.		

ANI-TPA	Team project A	Z	4
Team project. The graduate will gain experience in the following areas: project planning, management, and monitoring; ideation; risk analysis; and software support for teamwork. Teams are formed across specializations, so each group will also include students who will learn more details about project leadership, risk analysis, ideation, user interface design, and related topics in other courses of the program (for example, Software Product Development (ANI-TSW) or User Interface Design (ANI-NUR)). Students work on the projects independently with the support of collaboration tools. In particular, they will use GitLab Premium, which the faculty provides, and which supports a wide range of tools for managing and implementing team projects.			
ANI-TPB	Team project B	Z	7
ANI-TSP	Testing and Reliability	Z,ZK	5
Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with built-in-self-test equipment. They will be able to compute, analyze, and control the reliability and availability of the designed circuits.			
ANI-TSW	Software Product Development	Z,ZK	5
The course is presented in Czech.			
ANI-VIZ	Visualization	Z,ZK	6
In this course, you will get the knowledge of theoretical background for visualization and the application of visualization in real-world examples. The visualization methods are aimed at exploiting both the full power of computer technologies and the characteristics (and limits) of human perception. Well-chosen visualization method serves as an external representation, with which it is possible to quickly obtain data values or compare data. This frees up the memory and cognitive capabilities of the analyst to solve the problem that the data represents.			
ANI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines.			
BQM32KOS	Quantum optical communications and networks	Z,ZK	6
TThe goal of this course is to provide a comprehensive engineering insight into optical communications, with a specific focus on Quantum Key Distribution (QKD). The subject breaks down boundaries between traditional disciplines, integrating knowledge of wave optics, hardware architecture, and network security. Students will learn to perceive the communication system as a holistic entity, where the physical layer directly defines the limits and capabilities of digital security. The course prepares students for the real-world challenges associated with deploying quantum technologies into existing telecommunications infrastructure.			
FIT-ACM1	Programming Practices 1	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM2	Programming Practices 2	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM3	Programming Practices 3	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM4	Programming Practices 4	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM5	Programming Practices 5	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM6	Programming Practices 6	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-BIP	Blended Intensive Programme	Z	3
FIT-ITI	Modern IT infrastructure	Z,ZK	5
with a very limited and time-invariable range of software or hardware, this subject tries to explain the issue as a whole and in the context of the time. A modern data or computing center is understood here as a complex whole, the individual parts of which must be reconciled from different aspects of the view using current technologies. The proposed solution should thus be capable of continuous and economically optimal operation.			
FIT-PSD	Public Services Design	KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients.			
FIT-SEP	World Economy and Business	Z,ZK	4
This course is presented in Czech. The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.			
FIT-SM1	Machine Learning Seminar 1	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM2	Machine Learning Seminar 2	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM3	Machine Learning Seminar 3	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM4	Machine Learning Seminar 4	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			

FIT-SM5	Machine Learning Seminar 5	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM6	Machine Learning Seminar 6	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM7	Machine Learning Seminar 7	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-SM8	Machine Learning Seminar 8	Z	4
This seminar is led by experienced researchers and focuses on reviewing and understanding State-of-the-Art (SOTA) research papers in Machine Learning and AI. You will learn to: - Critically analyze research papers from top institutes and groups worldwide. - Understand the latest breakthroughswhat is being developed in leading research labs. - Master the methodology for properly reading and presenting scientific literature. The work in this seminar will prepare you to attend (and profit from) top international ML/AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
FIT-TOP	Academic writing	Z	2
Publishing is an important and required part of research activity. It is not only about obtaining research results but also about applying them in the form of a publication. Writing scientific publications can be useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the course, students will learn how to write a scientific article, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an article and reviewing someone else's article. The course will be taught in blocks, with a theoretical part at the beginning of the semester and one practical during the exam period. Dates will be determined based on the availability of enrolled students.			
FITE-EHD	Introduction to European Economic History	Z,ZK	3
The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion.			
FITE-GRI	Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.			
FITE-IL1	Completing a professional event	Z	1
The subject is participation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafting a report, etc.Such an event must be approved in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT through a website, infomail, etc.			
NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods).			
NI-AFP	Applied Functional Programming	KZ	5
This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice.			
NI-AIB	Algorithms of Information Security	Z,ZK	5
Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.			
NI-AML	Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of recommendation systems, image processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed.			
NI-AOS	Advanced Operating Systems	Z,ZK	5
The course focuses on system programming in Unix-like operating systems, with an emphasis on OS kernel development and advanced technologies for Unix system administration. Students will learn about the architecture and data structures of the OS kernel, process and memory management, the internal architecture of modern file systems, implementations of device control and network communication methods, kernel and OS booting techniques, as well as kernel debugging using dynamic instrumentation. They will also gain knowledge of kernel development and modification processes, ensuring kernel portability, and the use of containerization and virtualization technologies. Additionally, students will become familiar with the specifics of kernel implementation for embedded systems and real-time systems. Theoretical and general principles will be demonstrated primarily using the Linux kernel. The tutorials will focus on developing Linux kernel modules and using tools for managing the discussed technologies.			
NI-APH	Architecture of computer games	Z,ZK	4
Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also from design and philosophical perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base components that form an integral part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important part of the course is an implementation of a simple game, with a strong focus on nontrivial game mechanics.			
NI-APR	Selected Methods for Program Analysis	Z,ZK	5
This course introduces you to program analysisthe automated reasoning about the behavior of computer programs. We will cover both static and dynamic analysis. In static analysis, we explore the art of reasoning about programs without executing them, including techniques for program understanding, optimization, and error detection. In dynamic analysis, we examine individual program executions within specific environments and inputs.			
NI-APT	Advanced Program Testing	Z,ZK	5
Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.			

NI-ARI	Computer arithmetic	Z,ZK	4
Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.			
NI-ATH	AlgorithmicTheories of Games	Z,ZK	4
Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation.			
NI-BPS	Wireless Computer Networks	Z,ZK	4
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.			
NI-BSO	Biosignals and Biomedical Image Processing	Z,ZK	5
The aim of the course is to provide students with theoretical principles, techniques, and applications related to the processing and analysis of biological signals and medical images. During the course, students will work on examples of processing various biosignals in the MATLAB environment. After completing the course, students should be able to design and implement solutions to complex tasks for biosignals and biomedical images, interpret results, and apply their knowledge to real-world medical challenges.			
NI-CAP	Cultural and Social Anthropology	ZK	2
The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is presented in Czech.			
NI-CCC	Creative Coding and Computational Art	KZ	4
Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL).			
NI-CF1	Capture the Flag 1	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.			
NI-CF2	Capture the Flag 2	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.			
NI-CPX	Complexity Theory	Z,ZK	5
Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.			
NI-CPX.26	Complexity Theory	Z,ZK	6
Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.			
NI-CTF	Capture The Flag	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.			
NI-DDM	Distributed Data Mining	KZ	4
Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands on experience with large scale data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations and will be capable to propose approaches to parallelize other algorithms. The course is prezented in czech language.			
NI-DID	Digital drawing	Z	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color theory, which they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course is fit for anyone who wants to practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge.			
NI-DNP	Advanced .NET	Z,ZK	4
Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WPF, UWP), Blazor and also will get notions of Azure DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing technologies ASP.NET Core, Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.			
NI-DPH	Game Design	Z,ZK	5
The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game design. It is intended for people interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics design, storytelling, and game development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semestral projects.			
NI-DSV	Distributed Systems and Computing	Z,ZK	5
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communication channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that support high availability of both data and services, and safety in case of failures.			
NI-DSW	Design Sprint	Z	2
Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation).			
NI-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component.			
NI-DZO	Digital Image Processing	Z,ZK	4
This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting.			

NI-EDW	Enterprise Data Warehouse Systems	Z,ZK	5
The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowledge not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the area of reporting and data visualization.			
NI-EPC	Effective C++ programming	Z,ZK	5
Students learn how to use the modern features of contemporary versions of the C++ programming language for software development. The course focuses on programming effectivity and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time requirements.			
NI-ESC	Experimental Project Course	KZ	8
"The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, methodologies, and tools used in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design projects, collaborate with industry experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills in user-centered design and user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."			
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access time and memory complexity. They will be able to use the knowledge in design of applications that utilize pattern matching.			
NI-FMT	Finite model theory	Z,ZK	4
The aim of the course is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of logical properties of database systems. Since its inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as descriptive complexity theory, the Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.			
NI-GAK.26	Graph theory and combinatorics	Z,ZK	6
The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The emphasis will be not only on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topics from graph and hypergraph coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be also applied in the fields of combinatorics on words, formal languages and bioinformatics.			
NI-GEN	Code Generators	Z,ZK	5
Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of systems programming. This primarily involves understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming. Students will become familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.			
NI-GLR	Games and reinforcement learning	Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligence. This course is intended to give you both theoretical and practical background so you can participate in related research activities. Presented in English.			
NI-GNN	Graph Neural Networks	Z,ZK	4
The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural networks for creating vector representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last part of the course also covers graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.			
NI-GOL	Programming of distributed systems in GO	KZ	5
NI-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUDA programming environment, which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational structures, students will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.			
NI-HCM	Mind Hacking	ZK	5
Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, information systems and assets, the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive security is growing in importance in the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet environment have real societal impacts such as disruption of social cohesion, threats to democracy or war.			
NI-HMI2	History of Mathematics and Informatics	ZK	3
This course is presented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms, transformations, recursive functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development.			
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get familiar with various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with higher-order attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage.			
NI-HWB	Hardware Security	Z,ZK	5
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer.			
NI-IAM	Internet and Multimedia	Z,ZK	4
The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquisition of AV signals (input), presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical use case scenarios of real-time audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation for audience.			
NI-IBE	Information Security	ZK	2
Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international standards in this area. They understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., penetration testing).			
NI-IKM	Internet and Classification Methods	Z,ZK	4
In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering, in recommendation systems, in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving these four kinds of problems. On the background of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle with 2-hour lectures and 2-hour exercises. During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult their semester tasks.			

NI-IOS	Advanced techniques in iOS applications	KZ	4
Students will learn the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the basics from the beginners class BI-IOS.			
NI-IOT	Internet of Things	Z,ZK	4
The subject is focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is familiarization with available development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (GNU Forth).			
NI-IVS	Intelligent embedded systems	KZ	4
Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The course is an advance version of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programming and advance application development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students develop advanced applications combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies			
NI-KOD	Data Compression	Z,ZK	5
Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data compression methods being used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, students learn the fundamentals of lossy data compression methods used in image, audio, and video compression.			
NI-KRY	Advanced Cryptology	Z,ZK	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions.			
NI-KTH	Combinatorial Theories of Games	Z,ZK	4
Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics.			
NI-KYB	Cybernality	ZK	5
Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams).			
NI-LNG	Introduction to Linguistics for IT Students	ZK	2
This one-semester course should provide a gentle introduction to linguistics and language research for students majoring in IT and programming. Students get acquainted with basic concepts used in language descriptions as well as major theories influencing the current mainstream in linguistics. Specific attention will be paid to empirical and quantitative methods in linguistics, including the use of language corpora, and to specific issues of Czech.			
NI-LOM	Linear Optimization and Methods	Z,ZK	5
Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming.			
NI-LSM2	Statistical Modelling Lab	KZ	5
The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clutter, or video tracking. We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters.			
NI-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.			
NI-MKY.26	Mathematics for Cryptology	Z,ZK	7
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course focuses on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete logarithm. The problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.			
NI-MLP	Machine Learning in Practice	Z,ZK	5
Applying machine learning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ideally, technical implementation. The course guides students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically. The aim is to experience real data processing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and understandable report.			
NI-MMA	Multiplatform development of mobile applications	KZ	4
The course introduces students to a modern approach to native mobile app development for iOS and Android using cutting-edge technologies. Emphasis is placed on sharing code for business logic, the data layer, and network communication. Students will learn to structure projects effectively, access the native APIs of both platforms from the shared codebase, and solve common as well as advanced problems in multiplatform development. The lectures will feature concrete methodologies and practice-oriented case studies from industry professionals.			
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
Object-oriented programming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where its ability to natural abstraction is used to build complex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills of design and implementation of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development needs and areas of interest. In addition to deepening object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work on interesting projects and OO technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvement in the Pharo Consortium.			
NI-MPL	Managerial Psychology	ZK	2

NI-MPS	Modern Computer Networks	Z,ZK	5
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical semantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scott model of lambda calculus. Introduction to category theory.			
NI-MZI	Mathematics for data science	Z,ZK	4
In this course, students are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in data science. The studied topics include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle, gradient methods) and selected notions from probability theory and statistics.			
NI-NLM	Neural Language Models	Z	5
In this course, students will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The goal of the course is to teach students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific literature.			
NI-NMS	Neural Networks, Machine Learning and Randomness	Z,ZK	4
Stochastic methods, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a number of other machine learning models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks that rely substantially on randomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general stochastic approach to training neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including neural networks, are used in one of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms.			
NI-NMU	New media in art and design	ZK	3
The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game and sound. The main goal is to familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially in lectures devoted to specific art projects.			
NI-OLI	Linux Drivers	Z,ZK	4
The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining powerful processors and FPGAs increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development for master's students. The course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical experience.			
NI-PAM	Efficient Preprocessing and Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.			
NI-PDD	Data Preprocessing	Z,ZK	5
Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteristics from images or from web pages.			
NI-PG1	Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics.			
NI-PIV	Computer Vision	Z,ZK	5
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing.Students will get acquainted with the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical knowledge as well as on practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, ViT), motion detection, visual expressiveness (saliency).			
NI-PLS1	Programming Language Seminar	Z	2
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.			
NI-PLS2	Programming Language Seminar	Z	2
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.			
NI-PLS3	Programming Language Seminar	Z	2
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.			
NI-PLS4	Programming Language Seminar	Z	2
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.			
NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too.			
NI-PSD	Public Services Design	KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients.			

NI-PSL	Programming in Scala	Z,ZK	4
The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g.pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra, Scalaz, etc.			
NI-PVR	Advanced Virtual Reality	KZ	4
The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D models in Blender, and among other things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also deal with creating applications in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the knowledge gained in this subject in virtual reality, or directly create a complex game for VR.			
NI-PVS	Advanced embedded systems	Z,ZK	4
The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced topics like security support, working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical experiences with embedded systems.			
NI-PYT	Advanced Python	KZ	4
The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python (BI-PYT) left of. The course is very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework. The course is lead by external teachers from Red Hat.			
NI-REV	Reverse Engineering	Z,ZK	5
Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens before and after the main function is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedicated to reverse engineering of applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be dedicated to debuggers: how debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer malware scene. The focus of the course is on the seminars, where students will solve practically oriented tasks from the real world.			
NI-ROZ	Pattern Recognition	Z,ZK	5
The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.			
NI-RUB	Programming in Ruby	KZ	4
This course is presented in Czech.			
NI-RUN	Runtime Systems	Z,ZK	5
This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience in design and implementation of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compilation Memory management Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementations of real-world VMs, including Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs			
NI-SBF	System Security and Forensics	Z,ZK	5
Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication concepts). Furthermore, students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic analysis techniques and the importance of operating system/operating system artifacts or file system for attack analysis and detection).			
NI-SCE1	Computer Engineering Seminar Master I	Z	4
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in KČN laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester.			
NI-SCE2	Computer Engineering Seminar Master II	Z	4
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in KČN laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester.			
NI-SEM	Semantics of Programming Languages	Z,ZK	5
The aim of the course is to introduce students to the basics of programming language semantics, which forms the foundation for the study and implementation of programming languages. These techniques are also important for program verification, the implementation of optimizations, and the general design of programming languages. The emphasis will be on comparing operational and denotational semantics. The techniques used are also applicable when analysing languages specified only by an operational semantics. The course will enable students to acquire the skills needed to implement language constructs, regardless of whether their description comes from theoretical or engineering sources in the literature.			
NI-SEP	World Economy and Business	Z,ZK	4
This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.			
NI-SIB	Network Security	Z,ZK	5
NI-SYP	Parsing and Compilers	Z,ZK	5
The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.			
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet).			
NI-TKA	Category Theory	Z,ZK	4

NI-TNN	Theory of Neural Networks	Z,ZK	5
Artificial neural networks are now the foundation of artificial intelligence and the fastest-growing area of machine learning. This course introduces their theoretical foundations. It begins with general conceptsstructure, active dynamics, and adaptive dynamics (i.e., learning). Then it covers the theoretical basis of the most common types of artificial neural networks, from the perceptron of the 1950s to the transformer of 2017. Finally, using function approximation theory, it rigorously explains the most important theoretical result: the universal approximation capability of neural networks.			
NI-TNN.25	Theory of Neural Networks	Z,ZK	4
Artificial neural networks are now the foundation of artificial intelligence and the fastest-growing area of machine learning. This course introduces their theoretical foundations. It begins with general conceptsstructure, active dynamics, and adaptive dynamics (i.e., learning). Then it covers the theoretical basis of the most common types of artificial neural networks, from the perceptron of the 1950s to the transformer of 2017. Finally, using function approximation theory, it rigorously explains the most important theoretical result: the universal approximation capability of neural networks.			
NI-TS1	Theoretical Seminar Master I	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
NI-TS2	Theoretical Seminar Master II	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
NI-TS3	Theoretical Seminar Master III	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
NI-TS4	Theoretical Seminar Master IV	Z	4
Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.			
NI-TVR	Virtual Reality Technology	Z,ZK	3
Students will be introduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD, ...) and the possibilities of controlling virtual avatars (position tracking, hand tracking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of using virtual and augmented reality will be presented.			
NI-UMI.26	Artificial intelligence	Z,ZK	6
The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated.			
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development).			
NI-VEM	Scientific thinking	KZ	2
The objective of the course is to get acquainted with scientific methods and discovery of order and laws of the universe, including the aspects of human life. The subject combines scientific methods in natural sciences, mathematics, computer science and humanities. Another aim is to introduce rules and requirements of scientific communication via research papers and posters.			
NI-VGA	Video Games Architecture	Z,ZK	5
The course covers a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of view, but also from a design and philosophical point of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and functional architecture typical of game development, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, including ways of implementing some game mechanics, in the form of practical demonstrations.			
NI-VOL	Elections	Z,ZK	5
We will cover the basics of (committee) elections and, in general, opinion aggregation.			
NI-VPR	Research Project	Z	5
Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.			
NI-VYC	Computability	Z,ZK	4
Classical theory of recursive functions and effective computability.			
NIE-BLO	Blockchain	Z,ZK	5
Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platforms. They will be able to design, code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places an increased emphasis on the relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the students for implementing or supervising implementation of blockchain-based solutions in both academia and business.			
NIE-PDL	Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing.			
NIE-PML	Personalized Machine Learning	Z,ZK	5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.			
PI-SCN	Seminars on Digital Design	ZK	4
This subject deals with problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description of digital circuits and basic logic synthesis and optimization algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial problems emerging in EDA.			

QNI-CPX	Complexity Theory	Z,ZK	6
Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.			
QNI-KKP	Cryptology and Quantum Computing	Z,ZK	6
The course covers methods and algorithms of cryptology and their relation to quantum computing. In the first introductory lectures, students will be introduced to the basic principles and algorithms of cryptography. Following these topics, students will be introduced to basic cryptanalytic methods. Then some cryptanalytic algorithms running on quantum computers will be presented. In this context, the problem of security of related cryptographic schemes will be discussed. The next lectures will be devoted to post-quantum algorithms. The last lectures deal with cryptosystems using quantum phenomena.			
QNI-LOM	Linear Optimization and Methods	Z,ZK	5
Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming.			
QNI-MQI	Mathematics for Quantum Informatics	Z,ZK	6
Linear algebra on finite dimensional spaces with scalar product, Hilbert spaces, Dirac's bra-ket formalism, normal, Hermitian and unitary operators, operator spectrum, orthonormalization, diagonalization, matrix exponential, tensor product of vector spaces and operators. Discrete Fourier transform and fast Fourier transform.			
QNI-PPS	Programming of parallel systems	Z,ZK	6
Nowadays, multi-core processors and GPU accelerators have become common components of computing clusters and high-performance computing systems, so knowledge and skills related to parallel programming are essential for every computer scientist. The aim of this course is to introduce students to the architectures and programming methods of parallel computers with shared memory, GPU accelerators, or with distributed memory. To effectively use these modern computing systems, it is essential to combine parallelization techniques at all three levels. Students will gain knowledge of the relevant programming models, languages and environments. They will become familiar with fundamental parallel algorithms and be able to analyze the limitations, efficiency, and scalability of parallel solutions to selected problems on high-performance computing systems. In addition to the necessary theory in lectures, students will gain practical experience and skills in programming in OpenMP, CUDA and MPI environments.			
QNI-QC1	Quantum Computation 1	Z,ZK	6
The course introduces the student to basic principles of quantum computation and shows the difference between classical and quantum mechanics. Quantum computation uses quantum circuits, which will be demonstrated in the Qiskit SDK. The course will gradually introduce the student to such concepts the state of a quantum system and its visualization, measurements, basic gates and their composition, and the so-called entanglement. The student will be introduced to the BB84 and E91 protocols as demonstrations of the properties of quantum states. The course will also cover quantum teleportation, quantum oracle queries, the Deutsch-Jozsa algorithm, the quantum Fourier transform, the phase estimation algorithm, and the Shor algorithm.			
QNI-QC2	Quantum Computing 2	Z,ZK	6
Quantum Computing 2 focuses on advanced quantum algorithms and their implementations: the Grover algorithm and its applications, quantum algorithms solving linear algebra problems, HHL for solving systems of linear equations. In the course we also introduce students to variational methods and error correction.			
QNI-TIN	Information Theory	Z,ZK	6
The course focuses on the mathematical description of a random message source, its coding and transmission of the source through a noisy channel. The coding problem is addressed probabilistically, the relation of the mean length of the optimal code with the entropy and entropy rate of the random source is emphasized. In the case of the noisy channel we focus on the set of typical sequences and its appropriate coding by self-correcting codes. The course includes a reminder of necessary concepts such as conditional distributions, goodness-of-fit and independence tests, and an introduction to random chains.			
QNI-UKT	Introduction to Quantum Theory	Z,ZK	6
interpretation of quantum theory are explained using simple models mainly from finite-dimensional quantum mechanics. Emphasis is placed on further applications of quantum theory to information processing and communication. Possible physical realizations of a qubit, description of multipartite systems, quantum entanglement and its applications are discussed. The course concludes with a description of continuous quantum systems in infinite-dimensional Hilbert spaces, in particular the linear harmonic oscillator as a description of the mode of a quantized electromagnetic field.			

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