Study plan

Name of study plan: Web Engineering, Presented in Czech, Version 2020

Faculty/Institute/Others:
Department: Department of Software Engineering
Branch of study guaranteed by the department:
Garantor of the study branch: Ing. Jaroslav Kuchař, Ph.D.
Program of study: Informatics (2018 in Czech)
Type of study: Follow-up master full-time
Required credits: 98
Elective courses credits: 22
Sum of credits in the plan: 120
Note on the plan:

Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 63
The role of the block: PP

Code of the group: NI-PP.2020
Name of the group: Compulsory Courses of Master Study Program, Version 2020, in Czech
Requirement credits in the group: In this group you have to gain 63 credits
Requirement courses in the group: In this group you have to complete 6 courses
Credits in the group: 63
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
NI-KOP	**Combinatorial Optimization** *Jan Schmidt, Petr Fišer* ***Jan Schmidt*** *Jan Schmidt (Gar.)*	Z,ZK	6	3P+1C	Z	PP
NI-DIP	**Diploma Project** ***Zdeněk Muzikář***	Z	30		L,Z	PP
NI-MPR	**Master Project** ***Zdeněk Muzikář*** *Zdeněk Muzikář (Gar.)*	Z	7		Z	PP
NI-MPI	**Mathematics for Informatics** *Štěpán Starosta* ***Štěpán Starosta*** *Štěpán Starosta (Gar.)*	Z,ZK	7	3P+2C	Z	PP
NI-PDP	**Parallel and Distributed Programming** *Pavel Tvrdík* ***Pavel Tvrdík*** *Pavel Tvrdík (Gar.)*	Z,ZK	5	3P+1C	L	PP
NI-VSM	**Selected statistical Methods** *Daniel Vašata, Pavel Hrabák* ***Pavel Hrabák*** *Pavel Hrabák (Gar.)*	Z,ZK	8	4P+2C	L	PP

Characteristics of the courses of this group of Study Plan: Code=NI-PP.2020 Name=Compulsory Courses of Master Study Program, Version 2020, in Czech

NI-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems.			
NI-DIP	Diploma Project	Z	30
NI-MPR	Master Project	Z	7
1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. External Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR, MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of the department responsible for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.			
NI-MPI	Mathematics for Informatics	Z,ZK	7
The course comprises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analysis, smooth optimization and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic includes selected numerical algorithm and their stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear presentation and argumentation.			
NI-PDP	Parallel and Distributed Programming	Z,ZK	5
Due to the development of cloud, web, and communication technologies and due to the shift of the Moore law into parallelization of CPUs, parallel and distributed applications are becoming dominant. Students get acquainted with architectures of parallel and distributed computing systems and their models and with languages and environments for their programming. They learn the pattern designs for parallel and distributed programming and important parallel algorithms.			

NI-VSM	Selected statistical Methods	Z,ZK	8

Summary of probability theory; Multivariate normal distribution; Entropy and its application to coding; Statistical tests: T-tests, goodness of fit tests, independence test; Random processes - stacionarity; Markov chains and limiting properties; Queuing theory

Name of the block: Povinné předměty specializace
Minimal number of credits of the block: 35
The role of the block: PS

Code of the group: NI-PS-WI.2020
Name of the group: Compulsory Courses for Master Specialization Web Engineering, v.2020, in Czech
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
NI-AM1	**Middleware Architectures 1** *Tomáš Vitvar* ***Jaroslav Kuchař*** *Tomáš Vitvar (Gar.)*	Z,ZK	5	2P+1C	Z	PS
NI-AM2	**Middleware Architectures 2** *Jaroslav Kuchař, Tomáš Vitvar* ***Jaroslav Kuchař*** *Tomáš Vitvar (Gar.)*	Z,ZK	5	2P+1C	L	PS
NI-DDW	**Web Data Mining** *Milan Dojčinovski, Jaroslav Kuchař* ***Jaroslav Kuchař*** *Jaroslav Kuchař (Gar.)*	Z,ZK	5	2P+1C	L	PS
NI-PDB	**Advanced Database Systems** *Michal Valenta, Yelena Trofimova* ***Michal Valenta*** *Michal Valenta (Gar.)*	Z,ZK	5	2P+1C	Z	PS
NI-SWE	**Semantic Web and Knowledge Charts** *Milan Dojčinovski, Jakub Klímek* ***Milan Dojčinovski*** *Jakub Klímek (Gar.)*	Z,ZK	5	2P+1C	Z	PS
NI-VCC	**Virtualization and Cloud Computing** *Tomáš Vondra* ***Tomáš Vondra*** *Tomáš Vondra (Gar.)*	Z,ZK	5	2P+1C	L	PS
NI-VMM	**Retrieval from Multimedia** *Jiří Novák, Tomáš Skopal* ***Jaroslav Kuchař*** *Tomáš Skopal (Gar.)*	Z,ZK	5	2P+1C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NI-PS-WI.2020 Name=Compulsory Courses for Master Specialization Web Engineering, v.2020, in Czech

NI-AM1	Middleware Architectures 1	Z,ZK	5

Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications.

NI-AM2	Middleware Architectures 2	Z,ZK	5

Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.

NI-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.

NI-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.

NI-SWE	Semantic Web and Knowledge Charts	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.

NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
NI-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.

Name of the block: Povinně volitelné oborové předměty
Minimal number of credits of the block: 0
The role of the block: VO

Code of the group: NI-WI-VS.2020
Name of the group: Elective Vocational Courses for Master Specialization Web Engineering
Requirement credits in the group:
Requirement courses in the group:

Credits in the group: 0

Note on the group: Všechny povinné předměty specializací s výjimkou této specializace

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
NI-ADM	**Data Mining Algorithms** *Karel Klouda, Pavel Kordík, Daniel Vašata* ***Daniel Vašata*** *Pavel Kordík (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-AIB	**Algorithms of Information Security** *Martin Jureček, Róbert Lórencz* ***Róbert Lórencz*** *Róbert Lórencz (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-ADP	**Architecture and Design patterns** *Petr Špaček, Filip Křikava* ***Filip Křikava*** *Filip Křikava (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-BML	**Bayesian Methods for Machine Learning** *Kamil Dedecius, Ondřej Tichý* ***Ondřej Tichý*** *Kamil Dedecius (Gar.)*	KZ	5	2P+1C	L	VO
NI-BVS	**Embedded Security** *Martin Novotný* ***Martin Novotný*** *Martin Novotný (Gar.)*	Z,ZK	5	2P+2C	L	VO
NI-BKO	**Error Control Codes** *Pavel Kubalík, Hana Kubátová, Alois Pluháček* ***Pavel Kubalík*** *Hana Kubátová (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-DSV	**Distributed Systems and Computing** *Jan Janeček, Jan Fesl* ***Jan Janeček*** *Jan Janeček (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-EPC	**Effective C++ programming** *Daniel Langr* ***Daniel Langr*** *Daniel Langr (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-EVY	**Efficient Text Pattern Matching** *Jan Holub, Radomír Polách* ***Jan Holub*** *Jan Holub (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-FME	**Formal Methods and Specifications** *Stefan Ratschan* ***Stefan Ratschan*** *Stefan Ratschan (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-GEN	**Code Generators** *Jan Janoušek* ***Petr Máj*** *Jan Janoušek (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-GAK	**Graph theory and combinatorics** *Tomáš Valla, Štěpán Starosta* ***Štěpán Starosta*** *Štěpán Starosta (Gar.)*	Z,ZK	5	2P+2C	L	VO
NI-HWB	**Hardware Security** *Martin Novotný, Jiří Buček, Róbert Lórencz* ***Jiří Buček*** *Jiří Buček (Gar.)*	Z,ZK	5	2P+2C	L	VO
NI-KOD	**Data Compression** *Jan Holub* ***Jan Holub*** *Jan Holub (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-MKY	**Mathematics for Cryptology** *Štěpán Starosta, Čestmír Burdík* ***Štěpán Starosta*** *Čestmír Burdík (Gar.)*	Z,ZK	5	3P+1C	L	VO
NI-MVI	**Computational Intelligence Methods** *Pavel Kordík* ***Pavel Kordík*** *Pavel Kordík (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-MEP	**Modelling of Enterprise Processes** *Robert Pergl, Marek Skotnica* ***Robert Pergl*** *Robert Pergl (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-MPJ	**Modelling of Programming Languages** *Ryan Michael Culpepper* ***Ryan Michael Culpepper*** *Jan Vítek (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-MTI	**Modern Internet Technologies** *Viktor Černý, Alexandru Moucha* ***Alexandru Moucha*** *Alexandru Moucha (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-NON	**Nonlinear Continuous Optimization and Numerical Methods** *Jaroslav Kruis* ***Jaroslav Kruis*** *Jaroslav Kruis (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-NSS	**Normalized Software Systems** *Robert Pergl, Marek Suchánek, Jan Verelst* ***Robert Pergl*** *Robert Pergl (Gar.)*	ZK	5	2P	L	VO
NI-NUR	**User Interface Design** *Josef Pavlíček* ***Josef Pavlíček*** *Josef Pavlíček (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-OSY	**Operating Systems and Systems Programming** *Petr Máj, Filip Křikava* ***Filip Křikava*** *Filip Křikava (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-BUI	**Business Informatics** *Petra Pavlíčková* ***Petra Pavlíčková*** *Petra Pavlíčková (Gar.)*	Z,ZK	5	2P+2C	L	VO
NI-KRY	**Advanced Cryptology** *Jiří Buček, Róbert Lórencz, Simona Buchovecká* ***Jiří Buček*** *Róbert Lórencz (Gar.)*	Z,ZK	5	2P+2C	Z	VO
NI-PAS	**Advanced Aspects of Business** *David Buchtela, Zdeněk Kučera* ***David Buchtela*** *Zdeněk Kučera (Gar.)*	Z,ZK	4	2P+1C	Z	VO
NI-PIS	**Advanced Information Systems** *Tomáš Krátký* ***Tomáš Krátký*** *Tomáš Krátký (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-GPU	**GPU Architectures and Programming** *Ivan Šimeček* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-PDD	**Data Preprocessing** *Marcel Jiřina* ***Daniel Vašata*** *Marcel Jiřina (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-REV	**Reverse Engineering** *Jiří Dostál, Josef Kokeš, Róbert Lórencz* ***Jiří Dostál*** *Josef Kokeš (Gar.)*	Z,ZK	5	1P+2C	Z	VO
NI-RUN	**Runtime Systems** *Petr Máj, Jakub Podlešák* ***Jakub Podlešák*** *Jakub Podlešák (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-SIM	**Digital Circuit Simulation** *Martin Kohlík* ***Martin Kohlík*** *Martin Kohlík (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-SCR	**Statistical Analysis of Time Series** *Kamil Dedecius* ***Kamil Dedecius*** *Kamil Dedecius (Gar.)*	Z,ZK	5	2P+1C	Z	VO

NI-SYP	**Parsing and Compilers** *Jan Janoušek **Jan Janoušek** Jan Janoušek (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-SBF	**System Security and Forensics** *Jiří Dostál, Simona Buchovecká **Simona Buchovecká** Simona Buchovecká (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-DSS	**Decision Support Systems** *David Buchtela, Petra Pavlíčková, Robert Pergl **David Buchtela** Robert Pergl (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-SIB	**Network Security** *Tomáš Čejka, Jiří Smítka, Simona Buchovecká **Tomáš Čejka** Róbert Lórencz (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-TES	**Systems Theory** *Martin Daňhel, Stefan Ratschan **Stefan Ratschan** Stefan Ratschan (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-TSP	**Testing and Reliability** *Petr Fišer **Martin Daňhel** Petr Fišer (Gar.)*	Z,ZK	5	2P+2C	Z	VO
NI-TSW	**Software Product Development** *Petra Pavlíčková **Petra Pavlíčková** Petra Pavlíčková (Gar.)*	KZ	4	1P+2C	Z	VO
NI-UMI	**Artificial intelligence** *Pavel Surynek **Pavel Surynek** Pavel Surynek (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-EHW	**Embedded Hardware** *Jan Schmidt, Hana Kubátová **Jan Schmidt** Jan Schmidt (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-ESW	**Embedded Software** *Hana Kubátová, Miroslav Skrbek **Miroslav Skrbek** Hana Kubátová (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NI-APR	**Selected Methods for Program Analysis** *Filip Křikava **Filip Křikava** Filip Křikava (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-PON	**Selected Topics in Optimization and Numerical mathematics** *Karel Klouda, Štěpán Starosta **Štěpán Starosta** Štěpán Starosta (Gar.)*	Z,ZK	5	2P+1C	L	VO
NI-MCC	**Multicore CPU Computing** *Daniel Langr, Ivan Šimeček **Ivan Šimeček** Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	Z	VO

Characteristics of the courses of this group of Study Plan: Code=NI-WI-VS.2020 Name=Elective Vocational Courses for Master Specialization Web Engineering

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). They will acquire algorithmic methods of cryptocurrencies in order to analyze their security and efficiency. Another part of the course is dedicated to malware detection and use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.

NI-ADP	Architecture 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.

NI-BML	Bayesian Methods for Machine Learning	KZ	5

The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.

NI-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.

NI-BKO	Error Control Codes	Z,ZK	5

The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.

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-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-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-FME	Formal Methods and Specifications	Z,ZK	5

Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some software tools that allow to prove basic properties of software.

NI-GEN	Code Generators	Z,ZK	5

Students will become acquainted with both theoretical and practical aspects of back-end of an optimizing programming language compiler.

NI-GAK	Graph theory and combinatorics	Z,ZK	5
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-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-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-MKY	Mathematics for Cryptology	Z,ZK	5
Students become familiar with parts of mathematics necessary for deeper understanding of the methods used in symmetric and asymmetric cryptography. They learn the mathematical principles on which security of encryption systems, cryptanalysis methods, cryptography over elliptic curves, and quantum cryptography are based.			
NI-MVI	Computational Intelligence Methods	Z,ZK	5
Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to many problems. They will learn how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.			
NI-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.			
NI-MPJ	Modelling of Programming Languages	Z,ZK	5
The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve the semantics of the language. This course explores the semantics of programming languages. The students will learn the language models with emphasis on functional languages, students are expected to understand the basics of the lambda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with semantic modeling and execution tools.			
NI-MTI	Modern Internet Technologies	Z,ZK	5
SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration - A single network, oriented on TCP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video and data to achieve seamless integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of millions of users and billions of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and Traffic Prioritisation - These technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, delay, jitter, type of protocol). 4. Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of failures.			
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods to real-world problems. They will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They will learn to solve systems of linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement these algorithms sequentially as well as in parallel.			
NI-NSS	Normalized Software Systems	ZK	5
Students will learn the foundations of Normalized Systems theory, which studies the evolvability of modular structures based on concepts from engineering such as stability from systems theory and entropy from thermodynamics. Initially, the theory was developed at the level of software architectures, where the concept of stability was translated into the definition of so-called combinatorial effects. These effects occur when the impact of a change to the software architecture is dependent on the change itself, as well as on the size of the system. The latter is highly undesirable, as it will cause even a simple change to incur an ever-increasing impact as the size of the system grows over time. As such, combinatorial effects can be considered as a main cause of Lehman?s Law of Increasing Complexity (see, e.g., http://en.wikipedia.org/wiki/Lehman's_laws_of_software_evolution). Additionally, the concept of entropy was used in the study of which micro-states in a modular structure correspond with a given macro-state. This is related mainly to issues such as testing in software architectures. Normalized Systems theory consists first of a set of principles which indicate where violations of stability and entropy-related issues occur in any given software architecture. These principles indicate that very fine-grained modular structures are required in order to control them. In the second part of the theoretical framework, it is shown how software architectures can be constructed based on 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 controlling for violations of the stability and entropy-related principles, allowing them to realize new levels of evolvability in software architectures. Recently, Normalized Systems theory was also applied to the modular structures in business processes and enterprise architectures, with the goal of constructing a foundational theory for Enterprise Engineering.			
NI-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.			
NI-OSY	Operating Systems and Systems Programming	Z,ZK	5
NI-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).			
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-PAS	Advanced Aspects of Business	Z,ZK	4
NI-PIS	Advanced Information Systems	Z,ZK	5
Students learn the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of service oriented company, enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about agility and adaptivity and using of artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business processes, business rules, processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS.			
NI-GPU	GPU Architectures and Programming	Z,ZK	5

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-RUN	Runtime Systems	Z,ZK	5
Student become familiar - theoretically and practically - with runtime systems and virtual machines for various programming languages.			
NI-SIM	Digital Circuit Simulation	Z,ZK	5
Students gain information regarding the principles of quasi-parallel simulation of digital circuits at the RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and the properties of the tools used to perform these simulations. The course also covers current verification methods, especially UVM - Universal Verification Methodology.			
NI-SCR	Statistical Analysis of Time Series	Z,ZK	5
The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, employment) and industrial problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenient process model, estimate its parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main principles based on practical real-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer of students' knowledge from the academic to the real world.			
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-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.			
NI-SIB	Network Security	Z,ZK	5
The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically about detection and defense. The course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network traffic. The course focuses on explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general principals of handling detected security events (i.e. incident handling and incident response).			
NI-TES	Systems Theory	Z,ZK	5
Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems.			
NI-TSP	Testing and Reliability	Z,ZK	5
Students 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 easy testable circuits and systems with built-in-self-test equipment. They will be able to analyze and control reliability and availability of the designed circuits.			
NI-TSW	Software Product Development	KZ	4
The course is presented in Czech.			
NI-UMI	Artificial intelligence	Z,ZK	5
The subject deals in depth with modern approaches and algorithms used in contemporary artificial intelligence. Students will be introduced to advanced problem-solving techniques based on search and inference. A comprehensive overview of formal systems for problem modeling, related solving algorithms, and their practical applications will be presented. Emphasis will be placed on logical reasoning in artificial intelligence, which provides various guarantees, such as the completeness of the decision process or the precise justification of the decision. The lecture is based on the classical textbook of artificial intelligence [1]. The extra material on satisfiability, constraint programming, automated planning and robotics can be found in specialized textbooks [2], [3], [4], and [6]. Czech textbooks [5] are a suitable study material for the lecture as well.			
NI-EHW	Embedded Hardware	Z,ZK	5
The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures.			
NI-ESW	Embedded Software	Z,ZK	5
Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence.			
NI-APR	Selected Methods for Program Analysis	Z,ZK	5
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-MCC	Multicore CPU Computing	Z,ZK	5

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

Code of the group: NI-V.2020
Name of the group: Purely Elective Master Courses, Version 2020
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: 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
NI-IKM	**Internet and Classification Methods** *Martin Holeňa **Martin Holeňa** Martin Holeňa (Gar.)*	Z,ZK	4	1P+1C	L	v
NI-ATH	**AlgorithmicTheories of Games** *Tomáš Valla **Tomáš Valla** Tomáš Valla (Gar.)*	Z,ZK	4	2P+2C	L	v
BI-AG2	**Algorithms and Graphs 2** ***Josef Kolář***	Z,ZK	5	2P+2C	L	v
NI-AFP	**Applied Functional Programming** *Robert Pergl, Marek Suchánek, Jan Slifka **Robert Pergl** Robert Pergl (Gar.)*	KZ	5	2P+1C	L	v
NI-APH	**Architecture of computer games** *Adam Vesecký **Adam Vesecký** Adam Vesecký (Gar.)*	Z,ZK	4	2P+1C	Z	v
BI-APS	**Architecture of Computer Systems** *Michal Štepanovský Michal Štepanovský (Gar.)*	Z,ZK	6	2P+2C	Z	v
NI-BPS	**Wireless Computer Networks** *Alexandru Moucha **Alexandru Moucha** Alexandru Moucha (Gar.)*	Z,ZK	4	2P+1C	L	v
BI-BEK	**Secure Code** ***Róbert Lórencz***	Z,ZK	5	2P+2C	L	v
BI-BLE	**Blender** ***Lukáš Bařinka***	Z,ZK	4	2P+2C	L	v
NI-DZO	**Digital Image Processing** *Daniel Sýkora **Daniel Sýkora** Daniel Sýkora (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-DDM	**Distributed Data Mining** *Tomáš Borovička, Ondřej Stuchlík **Tomáš Borovička** Tomáš Borovička (Gar.)*	KZ	4	3C	L	v
NI-PAM	**Efficient Preprocessing and Parameterized Algorithms** *Ondřej Suchý **Ondřej Suchý** Ondřej Suchý (Gar.)*	Z,ZK	4	2P+1C	L	v
BI-EHA	**Ethical Hacking** ***Jiří Dostál***	Z,ZK	5	2P+2C	L	v
BI-FMU	**Financial and Management Accounting** *David Buchtela **David Buchtela** David Buchtela (Gar.)*	Z,ZK	5	2P+2C	Z	v
BI-FTR.1	**Financial Markets** ***Pavla Vozárová***	Z,ZK	5	2P+2C	L	v
NI-GLR	**Games and reinforcement learning** *Juan Pablo Maldonado Lopez **Juan Pablo Maldonado Lopez** Juan Pablo Maldonado Lopez (Gar.)*	Z,ZK	4	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** *Igor Čermák **Igor Čermák** Igor Čermák (Gar.)*	ZK	2	2P	Z	v
NI-IVS	**Intelligent embedded systems** *Miroslav Skrbek **Miroslav Skrbek** Miroslav Skrbek (Gar.)*	KZ	4	1P+3C	L	v
NI-IAM	**Internet and Multimedia** *Sven Ubik, Jiří Melnikov **Jiří Melnikov** Sven Ubik (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-IOT	**Internet of Things** *Jan Janeček **Peter Macejko** Jan Janeček (Gar.)*	Z,ZK	4	2P+1C	L	v
BI-JPO	**Computer Units** *Pavel Kubalík, Alois Pluháček **Alois Pluháček** Alois Pluháček (Gar.)*	Z,ZK	5	2P+2C	Z	v
NI-KTH	**Combinatorial Theories of Games** *Tomáš Valla **Tomáš Valla** Tomáš Valla (Gar.)*	Z,ZK	4	2P+1C	L	v
NI-CCC	**Creative Coding and Computational Art** *Radek Richtr **Radek Richtr** Radek Richtr (Gar.)*	KZ	4	1P+2C	Z	v
NI-KYB	**Cybernality** *Jan Kolouch **Jan Kolouch** Jan Kolouch (Gar.)*	ZK	5	2P	Z	v
NI-LOM	**Linear Optimization and Methods** *Michal Černý, Michal Rada **Michal Černý** Michal Černý (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-MPL	**Managerial Psychology** *Jan Fiala **Jan Fiala** Jan Fiala (Gar.)*	ZK	2	2+0	Z,L	v
NI-MSI	**Mathematical Structures in Computer Science** *Jan Starý **Jan Starý** Jan Starý (Gar.)*	Z,ZK	4	2P+1C	L	v

NI-MZI	**Mathematics for data science** *Štěpán Starosta* ***Štěpán Starosta*** *Štěpán Starosta (Gar.)*	Z,ZK	4	2P+1C	L	v
BI-MPP	**Methods of interfacing peripheral devices** *Miroslav Skrbek* ***Miroslav Skrbek*** *Miroslav Skrbek (Gar.)*	Z,ZK	4	2P+2C	Z	v
NI-MOP	**Modern Object-Oriented Programming in Pharo** *Jan Blizničenko, Marek Skotnica* ***Robert Pergl*** *Marek Skotnica (Gar.)*	KZ	4	3C	Z	v
NI-OLI	**Linux Drivers** *Miroslav Skrbek* ***Miroslav Skrbek*** *Miroslav Skrbek (Gar.)*	Z,ZK	4	2P+2C	L	v
NI-EDW	**Enterprise Data Warehouse Systems** *Magda Friedjungová* ***Karel Klouda*** *Magda Friedjungová (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-PVR	**Advanced Virtual Reality** *Petr Pauš* ***Petr Pauš*** *Petr Pauš (Gar.)*	KZ	4	2P+1C	Z	v
NI-IOS	**Advanced techniques in iOS applications** *Martin Půlpitel, Dominik Veselý* ***Martin Půlpitel*** *Martin Půlpitel (Gar.)*	KZ	4	2P+2C	L	v
NI-PVS	**Advanced embedded systems** *Miroslav Skrbek* ***Miroslav Skrbek*** *Miroslav Skrbek (Gar.)*	Z,ZK	4	2P+2C	Z	v
NI-DNP	**Advanced .NET** *Ondřej Dvořák, Marek Skotnica, David Šenkýř* ***Ondřej Dvořák*** *Ondřej Dvořák (Gar.)*	Z,ZK	4	2P+1C	Z	v
NI-PYT	**Advanced Python** *Miroslav Hrončok* ***Miroslav Hrončok*** *Miroslav Hrončok (Gar.)*	KZ	4	3C	Z	v
NI-ARI	**Computer arithmetic** *Alois Pluháček* ***Alois Pluháček*** *Alois Pluháček (Gar.)*	Z,ZK	4	2P+1C	Z,L	v
BI-PJP	**Programming Languages and Compilers** ***Jan Janoušek***	Z,ZK	5	2P+1C	L	v
NI-PSL	**Programming in Scala** *Jiří Daněček* ***Jiří Daněček*** *Jiří Daněček (Gar.)*	Z,ZK	4	2P+1C	L	v
BI-PMA	**Programming in Mathematica** *Zdeněk Buk Zdeněk Buk (Gar.)*	Z,ZK	4	2P+2C	Z	v
NI-RUB	**Programming in Ruby** *Cyril Černý* ***Cyril Černý*** *Cyril Černý (Gar.)*	KZ	4	3C	Z	v
NI-ROZ	**Pattern Recognition** *Michal Haindl* ***Michal Haindl*** *Michal Haindl (Gar.)*	Z,ZK	5	2P+1C	Z	v
NI-SCE1	**Computer Engineering Seminar Master I** *Hana Kubátová* ***Hana Kubátová*** *Hana Kubátová (Gar.)*	Z	4	2C	L,Z	v
NI-SCE2	**Computer Engineering Seminar Master II** ***Martin Novotný*** *Martin Novotný (Gar.)*	Z	4	2C	L,Z	v
NI-SZ1	**Knowledge Engineering Seminar Master I** ***Karel Klouda*** *Karel Klouda (Gar.)*	Z	4	2C	L,Z	v
NI-SZ2	**Knowledge Engineering Seminar Master II** ***Karel Klouda*** *Karel Klouda (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
BI-SVZ	**Machine vision and image processing** *Marcel Jiřina, Jakub Novák* ***Jakub Novák*** *Marcel Jiřina (Gar.)*	Z,ZK	5	2P+2C	Z	v
BI-SOJ	**Machine Oriented Languages** *Pavel Cimbál* ***Pavel Cimbál*** *Pavel Cimbál (Gar.)*	Z,ZK	4	2P+2C	L	v
NI-SEP	**World Economy and Business** *Tomáš Evan* ***Tomáš Evan*** *Tomáš Evan (Gar.)*	Z,ZK	4	2P+1C	Z	v
BI-SRC	**Real-time systems** *Jaroslav Borecký, Hana Kubátová* ***Hana Kubátová*** *Hana Kubátová (Gar.)*	KZ	4	2P+2C	Z	v
NI-TS1	**Theoretical Seminar Master I** ***Tomáš Valla*** *Tomáš Valla (Gar.)*	Z	4	2C	Z	v
NI-TS2	**Theoretical Seminar Master II** ***Tomáš Valla*** *Tomáš Valla (Gar.)*	Z	4	2C	L	v
NI-TS3	**Theoretical Seminar Master III** ***Tomáš Valla*** *Ondřej Suchý (Gar.)*	Z	4	2C	Z	v
NI-TS4	**Theoretical Seminar Master IV** ***Tomáš Valla*** *Tomáš Valla (Gar.)*	Z	4	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* ***Daniel Vašata*** *Martin Holeňa (Gar.)*	Z,ZK	5	2P+1C	L	v
NI-CPX	**Complexity Theory** *Dušan Knop, Ondřej Suchý* ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	Z,ZK	5	3P+1C	Z	v
BI-VHS	**Virtual game-worlds** *Radek Richtr* ***Radek Richtr*** *Radek Richtr (Gar.)*	ZK	4	2P+2C	Z	v
BI-VMM	**Selected Mathematical Methods** *Tomáš Kalvoda* ***František Štampach*** *Tomáš Kalvoda (Gar.)*	Z,ZK	4	2P+2C	L	v
NI-VYC	**Computability** *Jan Starý* ***Jan Starý*** *Jan Starý (Gar.)*	Z,ZK	4	2P+2C	L	v
NI-VPR	**Research Project** ***Štěpán Starosta*** *Štěpán Starosta (Gar.)*	Z	5		Z,L	v
NI-ZS10	**Master internship abroad for 10 credits** ***Zdeněk Muzikář*** *Zdeněk Muzikář (Gar.)*	Z	10		Z,L	v

NI-ZS20	**Master internship abroad for 20 credits** ***Zdeněk Muzikář*** *Zdeněk Muzikář (Gar.)*	Z	20		Z,L	v
NI-ZS30	**Master internship abroad for 30 credits** ***Zdeněk Muzikář*** *Zdeněk Muzikář (Gar.)*	Z	30		Z,L	v

Characteristics of the courses of this group of Study Plan: Code=NI-V.2020 Name=Purely Elective Master Courses, Version 2020

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-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.

BI-AG2	Algorithms and Graphs 2	Z,ZK	5

This course, presented in Czech, introduces basic algorithms and concepts of graph theory as a follow=up on the introduction given in the compulsory course BI-AG1. It further delves into advances data structures and amortized complexity analysis. It also includes a very light introduction to approximation algorithms. For English version of the course see BIE-AG2.

NI-AFP	Applied Functional Programming	KZ	5

This course is prezented 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 have a grasp of component-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 subject is an implementation of a simple game, with a strong focus on nontrivial game mechanics.

BI-APS	Architecture of Computer Systems	Z,ZK	6

Students understand architectures of uniprocessor computers at the level of machine instructions, with emphasis to instruction pipelining and memory hierarchy. They know the main concepts of RISC and CISC architectures. They learn how modern computers work and how they are constructed. They learn about the techniques that today's processors use to increase the program execution speed. They have a basic knowledge allowing them to optimise their programs to fully exploit the processors. They get an idea about the trends in the area of computer architectures and how will they affect software. They also understand the architectures of vector processors, their use in todays microprocessors. They understand the principles of shared-memory multiprocessor system architectures and the issues of memory consistency.

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.

BI-BEK	Secure Code	Z,ZK	5

The students will learn how to assess security risks and how to take them into account in the design phase of their own code and solutions. After getting familiar with the threat modeling theory, students gain practical experience with running programs with reduced privileges and methods of specifying these privileges, since not every program needs to run with administrator privileges. Dangers inherent in buffer overflows will be practically demonstrated. Students will be introduced to the principles of securing data and the relationships of security and database systems, web, remote procedure calls, and sockets in general. The module concludes with Denial of Service attacks and the defense against them.

BI-BLE	Blender	Z,ZK	4

The course extends knowledge of opensource program Blender from BI-MGA (Multimedia and Graphics Applications) course. It is intended for those interested in 3D graphics and animation. It offers a complete and practically oriented introduction to Blender environment. Students may continue to BI-PGA (Programming graphics applications) course.

NI-DZO	Digital Image Processing	Z,ZK	4

This course presents a comprehensive overview of modern methods for processing digital images and video. It mainly deals with practical algorithms used in professional image processing tools that are both easy to implement and have an interesting theoretical basis. Seemingly boring theorems from calculus, discrete mathematics, statistics and computer science come to life in visually attractive applications.

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-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.

BI-EHA	Ethical Hacking	Z,ZK	5

The course gives a professional and academic introduction to computer and information security using the ethical hacking approach, which enables improved defence thanks to adopting an attacker mindset when discovering vulnerabilities, hands-on experience with different attacks, facilitates linking theory and practice in significant areas of one's digital literacy, and can therefore be utilized by (future) security professionals, (informed) decision-makers, (savvy) users and developers alike. This course is taught in English.

BI-FMU	Financial and Management Accounting	Z,ZK	5

The aim of the course is explanation of basic terms in the theory of accounting, the principles of balancing the property amounts and liabilities in the particular accounting operations, operations in accounts and accounting statements including opening and closing of bookkeeping. The course provides students with a legal modification of bookkeeping, description of economic operations based on current methods of double-entry bookkeeping for enterprising subjects in the Czech Republic. Principles of management accounting are base of Business Inteligence moduls in Business information systems.

BI-FTR.1	Financial Markets	Z,ZK	5

This course is presented in Czech. However, there is an English variant in the program Informatics (B1801 / 4753).

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-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-IAM	Internet and Multimedia	Z,ZK	4
The MI-IAM course is focused on principles and modern technologies for audio and video (AV) signal processing and transferring across Internet in real time. The syllabus covers the mechanisms of recording and reproducing of AV signals, data transfer formats, interfaces, codecs, communication protocols for transfers of AV data, stereoscopy, and other AV data processing methods. Students will learn practical use of AV transfers in real-time for interesting applications. Within the labs, students will practically assemble transfer AV pipelines using HW and SW technologies and verify practically the effect of various components on the quality and latencies of AV data transfers over Internet. Students will learn how to build Internet infrastructure for realizing complete high-quality AV transfers from recording the scene up to 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).			
BI-JPO	Computer Units	Z,ZK	5
Students get knowledge of the internal structure and organization of computer or processor components and their interfacing with the environment, the organization of main memory and other internal memories (addressable, LIFO, FIFO, and CAM) and with design methodology for the control unit and controllers, basic principles of communication with peripheral devices and buses.			
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-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-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-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
This course is presented in Czech.			
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical semantics of programming languages.			
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.			
BI-MPP	Methods of interfacing peripheral devices	Z,ZK	4
The course is focused on methods interfacing peripheral devices. Interfacing of real devices is included with stress to Universal serial bus (USB). The course includes either PC side or attached devices. Labs are practically oriented. Students gain gain experience in implementation relevant parts of USB device, Linux and Windows drivers, simple application development, and APIs of selected devices.			

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-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-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-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-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-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 acquire a knowledge about advanced desgin of applicatios on a .NET platform. They gain skills of WPF (Windows Presentation Foundation), WCF/WebAPI (Windows Communication Foundation) and Entity Framework. They are able to apply these skills on a development and desgin of advanced .NET applications.			
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-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.			
BI-PJP	Programming Languages and Compilers	Z,ZK	5
Students master basic methods of implementation of common high-level programming languages. They get experience with the design and implementation of individual compiler parts for a simple programming language: data types, subroutines, and data abstractions. Students are able to formally specify a translation of a text that has a certain syntax into a target form and write a compiler based on such a specification. The notion of compiler in this context is not limited to compilers of programming languages, but extends to all other programs for parsing and processing text in a language defined by a LL(1) grammar.			
NI-PSL	Programming in Scala	Z,ZK	4
BI-PMA	Programming in Mathematica	Z,ZK	4
Students will be working with modern technical and scientific software. Students will learn how to use different programming styles (functional programming, rule-based programming, etc.), how to create dynamic interactive applications and visualisations, data processing and presentations.			
NI-RUB	Programming in Ruby	KZ	4
This course is presented in Czech.			
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-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-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.			

BI-SVZ	Machine vision and image processing	Z,ZK	5
Camera systems are becoming a common part of life by being universally available. Related to this phenomenon is the need to process and evaluate image information. The course introduces students to different types of camera systems and a variety of methods for image and video processing. The course is focused on practical use of camera systems for solving problems of practice that the graduates may encounter.			
BI-SOJ	Machine Oriented Languages	Z,ZK	4
Students of the course will gain an ability to create their own programs in the assembly language of the most common PC platform focusing on optimal use of microprocessor's features and efficient cooperation of software with hardware. Next, there will be discussed x86 specifics of the majority of OSes from the application point of view linked to higher level languages. This knowledge will be used during reverse engineering, optimization, and evaluation of code security.			
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.			
BI-SRC	Real-time systems	KZ	4
Students obtain the basic knowledge in the Real-time theory and in the design methods for RT systems including the dependability issues. Thereticla knowledges from lectures will be experimentally verified on the practical labs of the Department of Digital Design. This subject is mainly based on embedded R-T systems, therefore the used design kits are the same as in BI-VES subject and FPGA.			
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-TKA	Category Theory	Z,ZK	4
Mathematical semantics of programming languages.			
NI-TNN	Theory of Neural Networks	Z,ZK	5
In this course, we study neural networks from the point of view of the theory of function approximation and from the point of view of probability theory. At first, we recall basic concepts pertaining to artificial neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission, network topology, somatic and synaptic mappings, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transformation into a canonical topology, and in connection with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with training, we pay attention to the problem of overtraining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most important optimization methods employed for neural network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the topic approximation approach to neural networks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Kolmogorov theorem, Vituškin theorem). Afterwards, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings computed by neural networks being dense in important Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to a finite measure, spaces of functions with continuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expectation and training based on a random sample, and with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how it is possible to get an estimate of the conditional expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law of large numbers and get acquainted with an analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the central limit theorem, get acquinted with its analogy for neural networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be employed to search for the topology of the network.			
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.			
BI-VHS	Virtual game-worlds	ZK	4
The course leads students to create a complex virtual world. The course is a continuation of basic graphical courses (MGA, PGR, BLE,…). This current students knowledge is furthermore complemented by the theory of game design, principles of writing dialogues and characters in order to create a functional and complex virtual world. The course can be followed by the course MI-PVR with the task of converting scenes and their dynamics into a fully virtual environment suitable for VR devices.			
BI-VMM	Selected Mathematical Methods	Z,ZK	4
We start reviewing geometric properties of linear spaces with inner product. Next, we introduce and analyze the discrete Fourier transform (DFT) and its fast implementation (FFT). Further we deal with differential calculus of functions involving multiple variables. We present methods for the localization of extreme values of functions. For this purposes, we study normed linear spaces and quadratic forms. In addition, we introduce the least square method. The last part of the course is devoted to optimization and duality. The linear programming and the Simplex method is analyzed in more detail.			
NI-VYC	Computability	Z,ZK	4
Classical theory of recursive functions and effective computability.			
NI-VPR	Research Project	Z	5
The vice-dean acknowledges the student's credit for this subject for scientific results on faculty projects (eg publications, completion of the 2nd phase "Výlet", etc.)			
NI-ZS10	Master internship abroad for 10 credits	Z	10
Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.			

NI-ZS20	Master internship abroad for 20 credits	Z	20
Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.			
NI-ZS30	Master internship abroad for 30 credits	Z	30
The course is prezented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
BI-AG2	Algorithms and Graphs 2	Z,ZK	5
This course, presented in Czech, introduces basic algorithms and concepts of graph theory as a follow=up on the introduction given in the compulsory course BI-AG1. It further delves into advances data structures and amortized complexity analysis. It also includes a very light introduction to approximation algorithms. For English version of the course see BIE-AG2.			
BI-APS	Architecture of Computer Systems	Z,ZK	6
Students understand architectures of uniprocessor computers at the level of machine instructions, with emphasis to instruction pipelining and memory hierarchy. They know the main concepts of RISC and CISC architectures. They learn how modern computers work and how they are constructed. They learn about the techniques that today's processors use to increase the program execution speed. They have a basic knowledge allowing them to optimise their programs to fully exploit the processors. They get an idea about the trends in the area of computer architectures and how will they affect software. They also understand the architectures of vector processors, their use in todays microprocessors. They understand the principles of shared-memory multiprocessor system architectures and the issues of memory consistency.			
BI-BEK	Secure Code	Z,ZK	5
The students will learn how to assess security risks and how to take them into account in the design phase of their own code and solutions. After getting familiar with the threat modeling theory, students gain practical experience with running programs with reduced privileges and methods of specifying these privileges, since not every program needs to run with administrator privileges. Dangers inherent in buffer overflows will be practically demonstrated. Students will be introduced to the principles of securing data and the relationships of security and database systems, web, remote procedure calls, and sockets in general. The module concludes with Denial of Service attacks and the defense against them.			
BI-BLE	Blender	Z,ZK	4
The course extends knowledge of opensource program Blender from BI-MGA (Multimedia and Graphics Applications) course. It is intended for those interested in 3D graphics and animation. It offers a complete and practically oriented introduction to Blender environment. Students may continue to BI-PGA (Programming graphics applications) course.			
BI-EHA	Ethical Hacking	Z,ZK	5
The course gives a professional and academic introduction to computer and information security using the ethical hacking approach, which enables improved defence thanks to adopting an attacker mindset when discovering vulnerabilities, hands-on experience with different attacks, facilitates linking theory and practice in significant areas of one's digital literacy, and can therefore be utilized by (future) security professionals, (informed) decision-makers, (savvy) users and developers alike. This course is taught in English.			
BI-FMU	Financial and Management Accounting	Z,ZK	5
The aim of the course is explanation of basic terms in the theory of accounting, the principles of balancing the property amounts and liabilities in the particular accounting operations, operations in accounts and accounting statements including opening and closing of bookkeeping. The course provides students with a legal modification of bookkeeping, description of economic operations based on current methods of double-entry bookkeeping for enterprising subjects in the Czech Republic. Principles of management accounting are base of Business Inteligence moduls in Business information systems.			
BI-FTR.1	Financial Markets	Z,ZK	5
This course is presented in Czech. However, there is an English variant in the program Informatics (B1801 / 4753).			
BI-JPO	Computer Units	Z,ZK	5
Students get knowledge of the internal structure and organization of computer or processor components and their interfacing with the environment, the organization of main memory and other internal memories (addressable, LIFO, FIFO, and CAM) and with design methodology for the control unit and controllers, basic principles of communication with peripheral devices and buses.			
BI-MPP	Methods of interfacing peripheral devices	Z,ZK	4
The course is focused on methods interfacing peripheral devices. Interfacing of real devices is included with stress to Universal serial bus (USB). The course includes either PC side or attached devices. Labs are practically oriented. Students gain gain experience in implementation relevant parts of USB device, Linux and Windows drivers, simple application development, and APIs of selected devices.			
BI-PJP	Programming Languages and Compilers	Z,ZK	5
Students master basic methods of implementation of common high-level programming languages. They get experience with the design and implementation of individual compiler parts for a simple programming language: data types, subroutines, and data abstractions. Students are able to formally specify a translation of a text that has a certain syntax into a target form and write a compiler based on such a specification. The notion of compiler in this context is not limited to compilers of programming languages, but extends to all other programs for parsing and processing text in a language defined by a LL(1) grammar.			
BI-PMA	Programming in Mathematica	Z,ZK	4
Students will be working with modern technical and scientific software. Students will learn how to use different programming styles (functional programming, rule-based programming, etc.), how to create dynamic interactive applications and visualisations, data processing and presentations.			
BI-SOJ	Machine Oriented Languages	Z,ZK	4
Students of the course will gain an ability to create their own programs in the assembly language of the most common PC platform focusing on optimal use of microprocessor's features and efficient cooperation of software with hardware. Next, there will be discussed x86 specifics of the majority of OSes from the application point of view linked to higher level languages. This knowledge will be used during reverse engineering, optimization, and evaluation of code security.			

BI-SRC	Real-time systems	KZ	4
Students obtain the basic knowledge in the Real-time theory and in the design methods for RT systems including the dependability issues. Thereticla knowledges from lectures will be experimentally verified on the practical labs of the Department of Digital Design. This subject is mainly based on embedded R-T systems, therefore the used design kits are the same as in BI-VES subject and FPGA.			
BI-SVZ	Machine vision and image processing	Z,ZK	5
Camera systems are becoming a common part of life by being universally available. Related to this phenomenon is the need to process and evaluate image information. The course introduces students to different types of camera systems and a variety of methods for image and video processing. The course is focused on practical use of camera systems for solving problems of practice that the graduates may encounter.			
BI-VHS	Virtual game-worlds	ZK	4
The course leads students to create a complex virtual world. The course is a continuation of basic graphical courses (MGA, PGR, BLE,…). This current students knowledge is furthermore complemented by the theory of game design, principles of writing dialogues and characters in order to create a functional and complex virtual world. The course can be followed by the course MI-PVR with the task of converting scenes and their dynamics into a fully virtual environment suitable for VR devices.			
BI-VMM	Selected Mathematical Methods	Z,ZK	4
We start reviewing geometric properties of linear spaces with inner product. Next, we introduce and analyze the discrete Fourier transform (DFT) and its fast implementation (FFT). Further we deal with differential calculus of functions involving multiple variables. We present methods for the localization of extreme values of functions. For this purposes, we study normed linear spaces and quadratic forms. In addition, we introduce the least square method. The last part of the course is devoted to optimization and duality. The linear programming and the Simplex method is analyzed in more detail.			
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-ADP	Architecture 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.			
NI-AFP	Applied Functional Programming	KZ	5
This course is prezented 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). They will acquire algorithmic methods of cryptocurrencies in order to analyze their security and efficiency. Another part of the course is dedicated to malware detection and use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.			
NI-AM1	Middleware Architectures 1	Z,ZK	5
Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications.			
NI-AM2	Middleware Architectures 2	Z,ZK	5
Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.			
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 have a grasp of component-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 subject 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
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-BKO	Error Control Codes	Z,ZK	5
The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.			
NI-BML	Bayesian Methods for Machine Learning	KZ	5
The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.			
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-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).		
NI-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.		
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-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-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-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.		
NI-DIP	Diploma Project	Z	30
NI-DNP	Advanced .NET	Z,ZK	4
	Students acquire a knowledge about advanced desgin of applicatios on a .NET platform. They gain skills of WPF (Windows Presentation Foundation), WCF/WebAPI (Windows Communication Foundation) and Entity Framework. They are able to apply these skills on a development and desgin of advanced .NET applications.		
NI-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.		
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-DZO	Digital Image Processing	Z,ZK	4
	This course presents a comprehensive overview of modern methods for processing digital images and video. It mainly deals with practical algorithms used in professional image processing tools that are both easy to implement and have an interesting theoretical basis. Seemingly boring theorems from calculus, discrete mathematics, statistics and computer science come to life in visually attractive applications.		
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-EHW	Embedded Hardware	Z,ZK	5
	The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures.		
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-ESW	Embedded Software	Z,ZK	5
	Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence.		
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-FME	Formal Methods and Specifications	Z,ZK	5
	Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some software tools that allow to prove basic properties of software.		
NI-GAK	Graph theory and combinatorics	Z,ZK	5
	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
	Students will become acquainted with both theoretical and practical aspects of back-end of an optimizing programming language compiler.		
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-GPU	GPU Architectures and Programming	Z,ZK	5

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 MI-IAM course is focused on principles and modern technologies for audio and video (AV) signal processing and transferring across Internet in real time. The syllabus covers the mechanisms of recording and reproducing of AV signals, data transfer formats, interfaces, codecs, communication protocols for transfers of AV data, stereoscopy, and other AV data processing methods. Students will learn practical use of AV transfers in real-time for interesting applications. Within the labs, students will practically assemble transfer AV pipelines using HW and SW technologies and verify practically the effect of various components on the quality and latencies of AV data transfers over Internet. Students will learn how to build Internet infrastructure for realizing complete high-quality AV transfers from recording the scene up to 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-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems.			
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-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-MCC	Multicore CPU Computing	Z,ZK	5
NI-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.			

NI-MKY	Mathematics for Cryptology	Z,ZK	5
Students become familiar with parts of mathematics necessary for deeper understanding of the methods used in symmetric and asymmetric cryptography. They learn the mathematical principles on which security of encryption systems, cryptanalysis methods, cryptography over elliptic curves, and quantum cryptography are based.			
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-MPI	Mathematics for Informatics	Z,ZK	7
The course comprises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analysis, smooth optimization and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic includes selected numerical algorithm and their stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear presentation and argumentation.			
NI-MPJ	Modelling of Programming Languages	Z,ZK	5
The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve the semantics of the language. This course explores the semantics of programming languages. The students will learn the language models with emphasis on functional languages, students are expected to understand the basics of the lambda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with semantic modeling and execution tools.			
NI-MPL	Managerial Psychology	ZK	2
This course is presented in Czech.			
NI-MPR	Master Project	Z	7
1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. External Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR, MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of the department responsible for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.			
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical semantics of programming languages.			
NI-MTI	Modern Internet Technologies	Z,ZK	5
SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration - A single network, oriented on TCP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video and data to achieve seamless integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of millions of users and billions of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and Traffic Prioritisation - These technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, delay, jitter, type of protocol). 4. Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of failures.			
NI-MVI	Computational Intelligence Methods	Z,ZK	5
Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to many problems. They will learn how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.			
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-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods to real-world problems. They will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They will learn to solve systems of linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement these algorithms sequentially as well as in parallel.			
NI-NSS	Normalized Software Systems	ZK	5
Students will learn the foundations of Normalized Systems theory, which studies the evolvability of modular structures based on concepts from engineering such as stability from systems theory and entropy from thermodynamics. Initially, the theory was developed at the level of software architectures, where the concept of stability was translated into the definition of so-called combinatorial effects. These effects occur when the impact of a change to the software architecture is dependent on the change itself, as well as on the size of the system. The latter is highly undesirable, as it will cause even a simple change to incur an ever-increasing impact as the size of the system grows over time. As such, combinatorial effects can be considered as a main cause of Lehman?s Law of Increasing Complexity (see, e.g., http://en.wikipedia.org/wiki/Lehman's_laws_of_software_evolution). Additionally, the concept of entropy was used in the study of which micro-states in a modular structure correspond with a given macro-state. This is related mainly to issues such as testing in software architectures. Normalized Systems theory consists first of a set of principles which indicate where violations of stability and entropy-related issues occur in any given software architecture. These principles indicate that very fine-grained modular structures are required in order to control them. In the second part of the theoretical framework, it is shown how software architectures can be constructed based on 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 controlling for violations of the stability and entropy-related principles, allowing them to realize new levels of evolvability in software architectures. Recently, Normalized Systems theory was also applied to the modular structures in business processes and enterprise architectures, with the goal of constructing a foundational theory for Enterprise Engineering.			
NI-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.			
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-OSY	Operating Systems and Systems Programming	Z,ZK	5
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-PAS	Advanced Aspects of Business	Z,ZK	4
NI-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.

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-PDP	Parallel and Distributed Programming	Z,ZK	5

Due to the development of cloud, web, and communication technologies and due to the shift of the Moore law into parallelization of CPUs, parallel and distributed applications are becoming dominant. Students get acquainted with architectures of parallel and distributed computing systems and their models and with languages and environments for their programming. They learn the pattern designs for parallel and distributed programming and important parallel algorithms.

NI-PIS	Advanced Information Systems	Z,ZK	5

Students learn the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of service oriented company, enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about agility and adaptivity and using of artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business processes, business rules, processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS.

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-PSL	Programming in Scala	Z,ZK	4
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

Student become familiar - theoretically and practically - with runtime systems and virtual machines for various programming languages.

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-SCR	Statistical Analysis of Time Series	Z,ZK	5

The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, employment) and industrial problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenient process model, estimate its parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main principles based on practical

real-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer of students' knowledge from the academic to the real world.

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

The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically about detection and defense. The course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network traffic. The course focuses on explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general principals of handling detected security events (i.e. incident handling and incident response).

NI-SIM	Digital Circuit Simulation	Z,ZK	5

Students gain information regarding the principles of quasi-parallel simulation of digital circuits at the RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and the properties of the tools used to perform these simulations. The course also covers current verification methods, especially UVM - Universal Verification Methodology.

NI-SWE	Semantic Web and Knowledge Charts	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.

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-TES	Systems Theory	Z,ZK	5

Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems.

NI-TKA	Category Theory	Z,ZK	4

Mathematical semantics of programming languages.

NI-TNN	Theory of Neural Networks	Z,ZK	5

In this course, we study neural networks from the point of view of the theory of function approximation and from the point of view of probability theory. At first, we recall basic concepts pertaining to artificial neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission, network topology, somatic and synaptic mappings, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transformation into a canonical topology, and in connection with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with training, we pay attention to the problem of overtraining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most important optimization methods employed for neural network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the topic approximation approach to neural networks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Kolmogorov theorem, Vituškin theorem). Afterwards, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings computed by neural networks being dense in important Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to a finite measure, spaces of functions with continuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expectation and training based on a random sample, and with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how it is possible to get an estimate of the conditional expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law of large numbers and get acquainted with an analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the central limit theorem, get acquinted with its analogy for neural networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be employed to search for the topology of the network.

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-TSP	Testing and Reliability	Z,ZK	5
Students 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 easy testable circuits and systems with built-in-self-test equipment. They will be able to analyze and control reliability and availability of the designed circuits.			
NI-TSW	Software Product Development	KZ	4
The course is presented in Czech.			
NI-UMI	Artificial intelligence	Z,ZK	5
The subject deals in depth with modern approaches and algorithms used in contemporary artificial intelligence. Students will be introduced to advanced problem-solving techniques based on search and inference. A comprehensive overview of formal systems for problem modeling, related solving algorithms, and their practical applications will be presented. Emphasis will be placed on logical reasoning in artificial intelligence, which provides various guarantees, such as the completeness of the decision process or the precise justification of the decision. The lecture is based on the classical textbook of artificial intelligence [1]. The extra material on satisfiability, constraint programming, automated planning and robotics can be found in specialized textbooks [2], [3], [4], and [6]. Czech textbooks [5] are a suitable study material for the lecture as well.			
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
NI-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.			
NI-VPR	Research Project	Z	5
The vice-dean acknowledges the student's credit for this subject for scientific results on faculty projects (eg publications, completion of the 2nd phase "Výlet", etc.)			
NI-VSM	Selected statistical Methods	Z,ZK	8
Summary of probability theory; Multivariate normal distribution; Entropy and its application to coding; Statistical tests: T-tests, goodness of fit tests, independence test; Random processes - stacionarity; Markov chains and limiting properties; Queuing theory			
NI-VYC	Computability	Z,ZK	4
Classical theory of recursive functions and effective computability.			
NI-ZS10	Master internship abroad for 10 credits	Z	10
Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.			
NI-ZS20	Master internship abroad for 20 credits	Z	20
Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.			
NI-ZS30	Master internship abroad for 30 credits	Z	30
The course is prezented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.			
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.			

For updated information see http://bilakniha.cvut.cz/en/FF.html
Generated: day 28. 09. 2020, time 21:26.