Study plan

Name of study plan: Master branch System Programming, spec. Computer Science, in Czech, 2016-2017

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Informatics, valid until 2024
Type of study: Follow-up master full-time
Required credits: 89
Elective courses credits: 31
Sum of credits in the plan: 120
Note on the plan: Tato verze studijního plánu je určena pro ročník, který byl přijat ke studiu v akademickém roce 2016/2017 do prezenční formy studia magisterského programu.

Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 54
The role of the block: PP

Code of the group: MI-PP.2016
Name of the group: Compulsory Courses of Master Study Program, Version 2016, in Czech
Requirement credits in the group: In this group you have to gain 54 credits
Requirement courses in the group: In this group you have to complete at least 6 courses
Credits in the group: 54
Note on the group: Opakovaně do studia zapsaní studenti s uznatelnou zkouškou z PAR mohou požádat o uznání zkoušky z předmětu PDP.# Opozdilcům: Student, kteremu chybí PPR, si zapíše PDP a získá z něj zápočet.# Do studia opakovaně zapsaným studentů: student se zkouškou z PPR má právou na uznání zápočtu z PDP.

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
MI-DIP	**Diploma Project**	Z	23		L,Z	PP
MI-MPR	**Master Project**	Z	7		Z,L	PP
MI-MPI	**Mathematics for Informatics** ***Štěpán Starosta***	Z,ZK	7	3P+2C	Z	PP
MI-PDP.16	**Parallel and Distributed Programming**	Z,ZK	5	2P+2C	L	PP
MI-PAA	**Problems and Algorithms** ***Petr Fišer***	Z,ZK	5	2P+1R+1C	Z	PP
MI-SPI.16	**Statistics for Informatics**	Z,ZK	7	4P+2C	L	PP

Characteristics of the courses of this group of Study Plan: Code=MI-PP.2016 Name=Compulsory Courses of Master Study Program, Version 2016, in Czech

MI-DIP	Diploma Project	Z	23
MI-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.			
MI-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.			

MI-PDP.16	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 multicore and manycore CPUs, parallel and distributed applications are becoming ubiquitous. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks, and languages and environments for parallel programming of shared and distributed memory computers. On selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations.			
MI-PAA	Problems and Algorithms	Z,ZK	5
Students are able to evaluate discrete problems by complexity and by the purpose of optimisation (on-line tasks, multicriterial optimisation). They understand principles and properties of heuristics and exact algorithms and, therefore, are able to select, apply, and experimentally evaluate a suitable heuristics for a practical problem.			
MI-SPI.16	Statistics for Informatics	Z,ZK	7
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: Compulsory courses of the specialization
Minimal number of credits of the block: 8
The role of the block: PO

Code of the group: MI-PO-SP.2016
Name of the group: Compulsory Courses of Master Branch System Programming, in Czech, Version 2016
Requirement credits in the group: In this group you have to gain 8 credits
Requirement courses in the group: In this group you have to complete at least 2 courses
Credits in the group: 8
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
MI-FLP	**Functional and Logical Programming**	Z,ZK	4	2P+1C	L	PO
MI-SYP.16	**Parsing and Compilers**	Z,ZK	5	2P+1C	Z	PO

Characteristics of the courses of this group of Study Plan: Code=MI-PO-SP.2016 Name=Compulsory Courses of Master Branch System Programming, in Czech, Version 2016

MI-FLP	Functional and Logical Programming	Z,ZK	4
Students will be acquainted with principles of functional and logic programming. They will be able to write their programs in Lisp and Prolog programming languages.			
MI-SYP.16	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.			

Name of the block: Povinné předměty zaměření
Minimal number of credits of the block: 22
The role of the block: PZ

Code of the group: MI-PZ-SP-TI.2016
Name of the group: Compulsory Courses of Master Specialization Computer Science, Presented in Czech, Version 2016
Requirement credits in the group: In this group you have to gain 22 credits
Requirement courses in the group: In this group you have to complete at least 5 courses
Credits in the group: 22
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
MI-AVY	**Automata in Text Pattern Matching** *Ondřej Guth, Tomáš Pecka, Štěpán Plachý, Jan Trávníček, Jan Žďárek* ***Ondřej Guth*** *Ondřej Guth (Gar.)*	Z,ZK	4	2P+1C	L	PZ
MI-MVI.16	**Computational Intelligence Methods**	Z,ZK	5	2P+1C	Z	PZ
MI-NON.16	**Nonlinear Continuous Optimization and Numerical Methods**	Z,ZK	5	2P+1C	Z	PZ
MI-PAL	**Advanced Algorithms**	Z,ZK	4	2P+1C	L	PZ
MI-CPX	**Complexity Theory**	Z,ZK	5	3P+1C	Z	PZ

Characteristics of the courses of this group of Study Plan: Code=MI-PZ-SP-TI.2016 Name=Compulsory Courses of Master Specialization Computer Science, Presented in Czech, Version 2016

MI-AVY	Automata in Text Pattern Matching	Z,ZK	4
Searching in a text (pattern matching) and generally in data is an area of problems and exciting solutions from theoretical and practical perspectives. We may interpret and search the data as one-dimensional (text) or multi-dimensional (tree, picture). We may search for something known (a pattern: a string or a set specified by regular expression) or unknown (for example, a regularity). Matching can be either exact or approximate. This course presents a taxonomy of searching problems. It focuses on algorithms based on some automaton (finite, pushdown, linear-bounded, or tree).			
MI-MVI.16	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.			
MI-NON.16	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.			
MI-PAL	Advanced Algorithms	Z,ZK	4
The students will learn the most important advanced algorithms in different domains of the computer science that are not covered by modules of the Bachelor program Informatics and other modules of the Master program. They will also learn how to cope with problems that, according to the present knowledge, are not solvable optimally in polynomially bounded time.			
MI-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 (un)solvability of difficult problems.			

Name of the block: Compulsory elective economic-management courses
Minimal number of credits of the block: 2
The role of the block: VE

Code of the group: MI-PV-EM.2016
Name of the group: Compulsory Elective Master Economics and Management Courses , in Czech, Ver. 2016
Requirement credits in the group: In this group you have to gain at least 2 credits (at most 6)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 2)
Credits in the group: 2
Note on the group: Opakovaně do studia zapsaným studentům: Má-li student uznaný předmět PRM, nelze ho uznat jako náhradu za nový předmět PCM (student musí vypracovat projekt).

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
FI-VEZ	**economic-managerial course from a study abroad**	Z	4	0+0	Z,L	VE
MI-IBE	**Information Security**	ZK	2	2P	Z	VE
MI-MPX	**Management practice**	Z	4	5XD	Z,L	VE
MI-PCM.16	**Project And Change Management**	KZ	3	1P+2C	Z,L	VE
MI-SEP	**World Economy and Business**	Z,ZK	4	2P+1C	Z	VE

Characteristics of the courses of this group of Study Plan: Code=MI-PV-EM.2016 Name=Compulsory Elective Master Economics and Management Courses , in Czech, Ver. 2016

FI-VEZ	economic-managerial course from a study abroad	Z	4
A "Humanities subject that has been studied abroad" is covered by the Humanities subject from a study abroad in Compulsory Humanities Module that is required in the curriculum. The substitution is approved by the Vice-Dean for study affairs on behalf of the Dean at the request of the student.			
MI-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).			
MI-MPX	Management practice	Z	4
The Student can once, within its master's degree graduate (to apply) management practices in the selected subject of practice (business subject) on the operational, tactical or strategic level of management (typically at the position of project manager, middle or top manager). The selected subject of practice and professional filling is assessed well in advance the course guarantor. In the selected subject of practice may not have a substantial ownership interest or substantial decision-making influence of the relatives of the student (e.g. as a member of the top management).			
MI-PCM.16	Project And Change Management	KZ	3
This course is presented in Czech.			
MI-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.			

Name of the block: Compulsory elective humanities courses
Minimal number of credits of the block: 3
The role of the block: VH

Code of the group: MI-PV-HU.2016
Name of the group: Compulsory Elective Master Humanity Courses, Inclusive of Non-garanted Courses, Ver. 2016, in Czech
Requirement credits in the group: In this group you have to gain at least 3 credits (at most 6)
Requirement courses in the group: In this group you have to complete at least 1 course (at most 2)
Credits in the group: 3
Note on the group: If a student has attended one of the hum. courses offered here in bc. study, he must choose another

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-CAP	**Cultural and Social Anthropology** *Alena Libánská, Tomáš Houdek, Jakub Šenovský **Jakub Šenovský** Alena Libánská (Gar.)*	ZK	2	2P	Z	VH
FI-FIL	**Philosophy** *Peter Zamarovský **Peter Zamarovský** Peter Zamarovský (Gar.)*	ZK	2	2P	Z,L	VH
MI-HMI2	**History of Mathematics and Informatics**	ZK	3	2P+1C	Z	VH
FI-HTE	**History of Technology and Economics** *Jan Mikeš, Marcela Efmertová **Jan Mikeš** Jan Mikeš (Gar.)*	ZK	2	2+0	Z,L	VH
FI-HPZ	**Humanities subject from a study abroad**	Z	3	0+0	Z,L	VH
MI-KYB.16	**Cybernality**	ZK	5	2P	Z	VH
FI-MPL	**Managerial Psychology**	ZK	2	2+0	Z,L	VH
FI-KSA	**Cultural and Social Anthropology** ***Jakub Šenovský***	ZK	2	2P	L,Z	VH
FI-ULI	**Introduction to Linguistics for Computer**	ZK	2	2P	L	VH

Characteristics of the courses of this group of Study Plan: Code=MI-PV-HU.2016 Name=Compulsory Elective Master Humanity Courses, Inclusive of Non-garanted Courses, Ver. 2016, in Czech

NI-CAP	Cultural and Social Anthropology	ZK	2
The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is presented in Czech.			
FI-FIL	Philosophy	ZK	2
see A0B16			
MI-HMI2	History of Mathematics and Informatics	ZK	3
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.			
FI-HTE	History of Technology and Economics	ZK	2
The course introduces the scientific disciplines of history and technology , economic and social history of the Czech lands and Czechoslovakia in comparison with the development of the European region 19 to 21 century .			
FI-HPZ	Humanities subject from a study abroad	Z	3
A "Humanities subject that has been studied abroad" is covered by the Humanities subject from a study abroad in Compulsory Humanities Module that is required in the curriculum. The substitution is approved by the Vice-Dean for study affairs on behalf of the Dean at the request of the student.			
MI-KYB.16	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).			
FI-MPL	Managerial Psychology	ZK	2
FI-KSA	Cultural and Social Anthropology	ZK	2
The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is an interesting alternative to other humanities, taught at FIT.			
FI-ULI	Introduction to Linguistics for Computer	ZK	2
This course is presented in Czech.			

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

Code of the group: MI-V.2017
Name of the group: Purely Elective Master Courses, Version 2017
Requirement credits in the group:
Requirement courses in the group:

Credits in the group: 0

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

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
MI-IKM	**Internet and Classification Methods**	Z,ZK	4	1P+1C	L	v
MI-AFP	**Applied Functional Programming** ***Robert Pergl***	KZ	5	2P+1C	L	v
MI-APH	**Architecture of computer games**	Z,ZK	4	2P+1C	Z	v
MI-BML	**Bayesian Methods for Machine Learning**	KZ	5	2P+1C	L	v
MI-BPS	**Wireless Computer Networks**	Z,ZK	4	2P+1C	L	v
MI-DSP	**Database Systems in Practes**	Z,ZK	4	2P+1C	L	v
MI-DZO	**Digital Image Processing**	Z,ZK	4	2P+1C	L	v
MI-DDM	**Distributed Data Mining**	KZ	4	3C	L	v
MI-PAM	**Efficient Preprocessing and Parameterized Algorithms**	Z,ZK	4	2P+1C	L	v
MI-GLR	**Games and reinforcement learning**	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
MI-HMI2	**History of Mathematics and Informatics**	ZK	3	2P+1C	Z	v
MI-IVS	**Intelligent embedded systems**	KZ	4	1P+3C	L	v
NI-IAM	**Internet and Multimedia**	Z,ZK	4	2P+1C	L	v
MI-IOT	**Internet of Things**	Z,ZK	4	2P+1C	L	v
MI-ATH	**Combinatorial Theories of Games**	Z,ZK	4	2P+2C	L	v
NI-CCC	**Creative Coding and Computational Art** *Josef Kortán, Radek Richtr* ***Radek Richtr*** *Radek Richtr (Gar.)*	KZ	4	1P+2C	Z,L	v
NI-LSM	**Statistical Modelling Lab** *Kamil Dedecius* ***Kamil Dedecius*** *Kamil Dedecius (Gar.)*	KZ	5	3C	L	v
MI-LOM.16	**Linear Optimization and Methods**	Z,ZK	5	2P+1C	Z	v
MI-MSI	**Mathematical Structures in Computer Science**	Z,ZK	4	2P+1C	L	v
MI-MZI	**Mathematics for data science**	Z,ZK	4	2P+1C	L	v
NI-MOP	**Modern Object-Oriented Programming in Pharo** *Marek Skotnica, Jan Blizničenko* ***Robert Pergl*** *Robert Pergl (Gar.)*	KZ	4	3C	Z	v
MI-MPC	**Modern programming in C ++**	Z,ZK	5	2P+1C	Z	v
MI-MAI	**Multimedia and Internet**	Z,ZK	3	2P+1C	L	v
MI-OLI	**Linux Drivers**	Z,ZK	4	2P+2C	L	v
MI-ARI	**Computer arithmetic**	Z,ZK	4	2P+1C	Z,L	v
NI-PG1	**Computer Grafics 1** *Radek Richtr* ***Radek Richtr*** *Radek Richtr (Gar.)*	ZK	4	2P+1C	L	v
MI-PVR	**Advanced Virtual Reality**	KZ	4	2P+1C	Z	v
NI-AML	**Advanced machine learning** *Miroslav Čepek, Petr Šimánek, Vojtěch Rybář, Rodrigo Augusto Da Silva Alves, Zdeněk Buk* ***Miroslav Čepek*** *Miroslav Čepek (Gar.)*	Z,ZK	5	2P + 1C	L	v
MI-IOS	**Advanced techniques in iOS applications**	KZ	4	2P+2C	L	v
MI-PVS	**Advanced embedded systems**	Z,ZK	4	2P+2C	Z	v
MI-DNP	**Advanced .NET**	Z,ZK	4	2P+1C	Z	v
MI-PYT	**Advanced Python**	KZ	4	3C	Z	v
MI-PRC	**Programming in CUDA**	Z,ZK	4	2P+1C	L	v
MI-PSL	**Programming in Scala**	Z,ZK	4	2P+1C	L	v
MI-RUB	**Programming in Ruby**	KZ	4	3C	Z	v
MI-ROZ.16	**Pattern Recognition**	Z,ZK	5	2P+1C	Z	v
MI-RRI	**Risk Management in Informatics**	ZK	3	2P	L	v
MI-SCE1	**Computer Engineering Seminar Master I**	Z	4	2C	L,Z	v
MI-SCE2	**Computer Engineering Seminar Master II**	Z	4	2C	L,Z	v
MI-SZ1	**Knowledge Engineering Seminar Master I**	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
MI-SCR	**Statistical Analysis of Time Series**	Z,ZK	4	2P+1C	Z	v
BI-SOJ	**Machine Oriented Languages**	Z,ZK	4	2P+2C	L	v
MI-TS1	**Theoretical Seminar Master I**	Z	4	2C	Z	v
MI-TS2	**Theoretical Seminar Master II**	Z	4	2C	L	v
MI-TS3	**Theoretical Seminar Master III**	Z	4	2C	Z	v
MI-TS4	**Theoretical Seminar Master IV**	Z	4	2C	L	v
MI-TNN	**Theory of Neural Networks**	Z,ZK	4	1P+1C	L	v
MI-VEM	**Scientific thinking**	KZ	2	1P+1C	L	v
MI-MCS	**Multicore Systems**	KZ	4	1P+2C	Z	v
MI-VYC	**Computability**	Z,ZK	4	2P+2C	L	v
NI-VPR	**Research Project** *Štěpán Starosta* ***Štěpán Starosta*** *Štěpán Starosta (Gar.)*	Z	5		Z,L	v
MI-ZS10	**Master internship abroad for 10 credits**	Z	10		Z,L	v
MI-ZS20	**Master internship abroad for 20 credits**	Z	20		Z,L	v
MI-ZS30	**Master internship abroad for 30 credits**	Z	30		Z,L	v

Characteristics of the courses of this group of Study Plan: Code=MI-V.2017 Name=Purely Elective Master Courses, Version 2017

MI-HMI2	History of Mathematics and Informatics	ZK	3

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.

MI-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.

MI-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.

MI-APH	Architecture of computer games	Z,ZK	4

Students will gain a basic understanding of the various issues in the field of computer game development, from both the technical and creative points of view. They will get a grasp on component-oriented architecture, game mechanics, and game AI 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).

MI-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.

MI-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.

MI-DSP	Database Systems in Practes	Z,ZK	4

This course is presented in Czech.

MI-DZO	Digital Image Processing	Z,ZK	4

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

MI-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.

MI-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.

MI-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.			
MI-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 NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquisition of AV signals (input), presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical use case scenarios of real-time audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation for audience.			
MI-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).			
MI-ATH	Combinatorial Theories of Games	Z,ZK	4
This course is presented in Czech.			
NI-CCC	Creative Coding and Computational Art	KZ	4
Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,…) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL).			
NI-LSM	Statistical Modelling Lab	KZ	5
The subject is oriented on a single and multi-target tracking. The student both learns the existing methods and tries to implement them. The stress is put on the effective use of the available information and its modeling using numpy and scipy. The second half of the semester is focused on the design of methods and algorithms, and analyses of their properties. At this point, the subject is on the border of own research and may result in the topic of final work (diploma or bachelor thesis).			
MI-LOM.16	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.			
MI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical semantics of programming languages.			
MI-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-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.			
MI-MPC	Modern programming in C ++	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.			
MI-MAI	Multimedia and Internet	Z,ZK	3
The course will cover principles and technologies for processing and network transmissions of multimedia signals, stereoscopy and visualizations in high definition. Lectures will include application areas of networked multimedia, transmission formats, interfaces, codecs, technologies for acquisition and reproduction of multimedia data and technologies for visualizations and distributed collaboration using networking and immersive environments.			
MI-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.			
MI-ARI	Computer arithmetic	Z,ZK	4
Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.			
NI-PG1	Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics.			
MI-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-AML	Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of recommendation systems, image processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed.			

MI-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.			
MI-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.			
MI-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.			
MI-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.			
MI-PRC	Programming in CUDA	Z,ZK	4
The students gain a good overview of present parallel architectures in GPUs. Students also get hands-on experience with programming these systems.			
MI-PSL	Programming in Scala	Z,ZK	4
The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g.pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra, Scalaz, etc.			
MI-RUB	Programming in Ruby	KZ	4
This course is presented in Czech.			
MI-ROZ.16	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.			
MI-RRI	Risk Management in Informatics	ZK	3
Information security is very often considered as one of main objectives to secure targets of information processing. However, to focus on this info security as a matter of protection of IT systems against viruses, malware etc. very often means misunderstanding and underestimating of real threats which are around us and which are more dangerous then viruses and other malware. The necessity to continue with business after disaster is also slightly ignored. International standards which are focused on informatics and information security just during last years started to anticipate necessity of risk management. There is no commonly accepted methodology used for this task. Threats which are currently possible to see worldwide, invoke pressures to prepare plans for business continuity management even in the case of dramatic political changes, natural disasters etc.			
MI-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.			
MI-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.			
MI-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).			
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.			
MI-SCR	Statistical Analysis of Time Series	Z,ZK	4
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.			
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.			
MI-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.			
MI-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.			
MI-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.			

MI-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.			
MI-TNN	Theory of Neural Networks	Z,ZK	4
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.			
MI-VEM	Scientific thinking	KZ	2
The objective of the course is to get acquainted with scientific methods and discovery of order and laws of the universe, including the aspects of human life. The subject combines scientific methods in natural sciences, mathematics, computer science and humanities. Another aim is to introduce rules and requirements of scientific communication via research papers and posters.			
MI-MCS	Multicore Systems	KZ	4
Students understand architecture of systems based on multicore processors with multiple threads per core, structure and usage of cache hierarchy with shared last level. They learn parallel algorithm classification, parallel programming technics, simulation and monitoring tools for measurement and optimization of parallel algorithms. After this course, students can design MTMD programs (Multiple Threads Multiple Data), measure and analyze latency and throughput of parallel algorithms and optimize them for contemporary multicore systems.			
MI-VYC	Computability	Z,ZK	4
Classical theory of recursive functions and effective computability, with applications in provability theory.			
NI-VPR	Research Project	Z	5
Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.			
MI-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.			
MI-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.			
MI-ZS30	Master internship abroad for 30 credits	Z	30
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.			

Code of the group: MI-SP-TI-VO.2017
Name of the group: Elective Vocational Courses for Master Specialisation MI-SP-TI, version 2017
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: Compulsory courses of all branches and specializations with the exception of this branch.

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
MI-ADM.16	**Data Mining Algorithms**	Z,ZK	5	2P+1C	L	v
MI-ADP.16	**Architecture and Design Patterns**	Z,ZK	5	2P+1C	Z	v
MI-BPR	**Security and Secure Programming**	Z,ZK	4	2P+1C	Z	v
MI-BHW.16	**Security and Hardware** ***Martin Novotný***	Z,ZK	5	2P+2C	L	v
MI-BKO.16	**Error Control Codes**	Z,ZK	5	2P+1C	L	v
MI-DSV.16	**Distributed Systems and Computing**	Z,ZK	5	2P+1C	Z	v

MI-DDW.16	**Web Data Mining**	Z,ZK	5	2P+1C	L	v
MI-FME.16	**Formal Methods and Specifications**	Z,ZK	5	2P+1C	L	v
MI-GEN	**Code Generators**	Z,ZK	4	2P+1C	L	v
MI-HWB.16	**Hardware Security**	Z,ZK	5	2P+2C	L	v
MI-KOD.16	**Data Compression**	Z,ZK	5	2P+1C	L	v
MI-MKY.16	**Mathematics for Cryptology**	Z,ZK	5	3P+1C	L	v
MI-MVI.16	**Computational Intelligence Methods**	Z,ZK	5	2P+1C	Z	v
MI-MEP.16	**Modelling of Business Processes** ***Robert Pergl***	Z,ZK	5	2P+1C	Z	v
MI-MTI.16	**Modern Internet Technologies**	Z,ZK	5	2P+1C	Z	v
MI-NFA.16	**Design for the FPGA and ASIC Technology**	Z,ZK	5	2P+1C	Z	v
MI-NUR.16	**User Interface Design**	Z,ZK	5	2P+1C	Z	v
MI-NSS.16	**Normalized Software Systems** ***Robert Pergl***	ZK	5	2P	L	v
MI-PAP.16	**Parallel Computer Architectures**	Z,ZK	5	2P+1C	L	v
MI-EDW.16	**Enterprise Data Warehouse Systems**	Z,ZK	5	2P+1C	L	v
MI-KRY.16	**Advanced Cryptology**	Z,ZK	5	2P+2C	Z	v
MI-POA.16	**Advanced Computer System Architectures**	Z,ZK	5	2P+1C	L	v
MI-PDB.16	**Advanced Database Systems**	Z,ZK	5	2P+1C	Z	v
MI-PIS.16	**Advanced Information Systems**	Z,ZK	5	2P+1C	L	v
MI-PCM.16	**Project And Change Management**	KZ	3	1P+2C	Z,L	v
MI-PDD.16	**Data Preprocessing**	Z,ZK	5	2P+1C	Z	v
MI-REV.16	**Reverse Engineering**	Z,ZK	5	1P+2C	Z	v
MI-MBI.16	**Management of Business Informatics**	Z,ZK	5	3P+1C	L	v
MI-SWE.16	**Semantic Web**	Z,ZK	5	2P+1C	Z	v
MI-SIB.16	**Network Security**	Z,ZK	5	2P+1C	L	v
MI-SMI.16	**Strategic Management of Informatics**	Z,ZK	5	3P+1C	Z	v
MI-SYB.16	**System Security**	Z,ZK	5	2P+2C	L	v
MI-SOC.16	**Systems on Chip**	Z,ZK	5	2P+1C	Z	v
MI-TES.16	**Systems Theory**	Z,ZK	5	2P+1C	Z	v
MI-TSP.16	**Testing and Reliability** ***Petr Fišer***	Z,ZK	5	2P+2C	Z	v
MI-VMM.16	**Retrieval from Multimedia**	Z,ZK	5	2P+1C	Z	v
MI-W20.16	**Web 2.0**	Z,ZK	5	2P+1C	L	v
MI-MDW.16	**Web Services and Middleware**	Z,ZK	5	2P+1C	Z	v

Characteristics of the courses of this group of Study Plan: Code=MI-SP-TI-VO.2017 Name=Elective Vocational Courses for Master Specialisation MI-SP-TI, version 2017

MI-MVI.16	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.

MI-PCM.16	Project And Change Management	KZ	3

This course is presented in Czech.

MI-ADM.16	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).

MI-ADP.16	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.

MI-BPR	Security and Secure Programming	Z,ZK	4

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.

MI-BHW.16	Security and Hardware	Z,ZK	5

Students gain a basic knowledge in selected topics of cryptography and cruptanalysis. The module focuses particularly on elliptic curve cryptography, and on contemporary attacks on cryptographic systems. Students gain a good overview of the functionality of (hardware) cryptographic accelerators, random number generators, smart cards, and resources for securing of internal functions of computer systems.

MI-BKO.16	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.			
MI-DSV.16	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.			
MI-DDW.16	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 and search, 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.			
MI-FME.16	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.			
MI-GEN	Code Generators	Z,ZK	4
Students will become acquainted with both theoretical and practical aspects of back-end of an optimizing programming language compiler.			
MI-HWB.16	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.			
MI-KOD.16	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.			
MI-MKY.16	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.			
MI-MEP.16	Modelling of Business 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.			
MI-MTI.16	Modern Internet Technologies	Z,ZK	5
Students learn technologies of the modern Internet. links of the IP technology to the modern communication networks, mechanisms for multicasting and real-time communication, more efficient mechanisms of virtual channels, and the new IPv6 architecture. They will understand the issues of monitoring and management of large computer networks. They are introduced to the technologies of interconnection networks for HPC systems.			
MI-NFA.16	Design for the FPGA and ASIC Technology	Z,ZK	5
Students gain the basic knowledge needed to start a career in a design house. They will understand the FPGA and ASIC implementation technologies and the limitations that the technologies impose on the design. They are able to perform and to manage typical workflows, their analytic and synthetic steps, with an emphasis on basic verification. They know the structure and demands of software tools, as well as what to expect from them.			
MI-NUR.16	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.			
MI-NSS.16	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.			
MI-PAP.16	Parallel Computer Architectures	Z,ZK	5
The students gain a good overview of present parallel architectures and processors:parallel (ILP) microarchitectures, multithreaded and multicore processors, SoCs and MPSoCs, GPUs, and neural processors. Students also get hands-on experience with programming these systems.			
MI-EDW.16	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.			
MI-KRY.16	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.			
MI-POA.16	Advanced Computer System Architectures	Z,ZK	5
The student will learn the current trends in infrastructure architecture of complex business computer systems. After completion of the module, the student will be able to design a complex system infrastructure that meets availability and scalability requirements given by the business environment.			
MI-PDB.16	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.			

MI-PIS.16	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.			
MI-PDD.16	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 parameters from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve a specific problem in individual projects - e.g., parameter extraction from image data or from Internet.			
MI-REV.16	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.			
MI-MBI.16	Management of Business Informatics	Z,ZK	5
This course is presented in Czech.			
MI-SWE.16	Semantic Web	Z,ZK	5
Students learn standards used for processing and sharing knowledge mainly in the area of web. They get used to designing and using knowledge models, knowledge representation, and practical aspects as publishing, sharing, exchange, and acquisition of knowledge on the web. The presentation is based on the idea of the semantic web, including its standards and technologies (RDF, RDFS, OWL) and formal models.			
MI-SIB.16	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).			
MI-SMI.16	Strategic Management of Informatics	Z,ZK	5
The course focuses on the strategic management of information systems. Students will learn the process of creation and implementation of an information strategy, IT governance, the importance of ICT for business and interrelations between information strategies and lobal business strategies. Furthermore, they gain the knowledge in the areas of economic management of IS/IT, management of investments and ROI, assessment of IT investments and management of human resources in IT (the role of CIO, CEO, CFO). The part of the course is the role of project management, risk management and quality assessment of informatics.			
MI-SYB.16	System Security	Z,ZK	5
Students will familiarize themselves with the actual ICT security needs in all ICT disciplines. Students will gain knowledge of typical network attacks and protection against them, together with essential communication encryption techniques. They will learn how to work with certain aspects of encryption techniques - passwords and certificates. After that, students will learn the basics of anti-virus, anti-spam and heuristic analyses used in modern anti-virus solutions or Unified Threat Management (UTM) based solutions. They will also learn the principles of securing websites, web applications and databases. Upon completion of the module, students will have a broad overview of IT security and will be able to apply it to the integration of various software systems and applications.			
MI-SOC.16	Systems on Chip	Z,ZK	5
Students gain key knowledge and skills in the design of large-scale digital systems. They will be familiar with architectures of such systems and communication among their parts. They will use an appropriate workflow to design these architectures, their hardware and software. They will also have knowledge of contemporary methods of large systems verification and fault-tolerant systems design.			
MI-TES.16	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.			
MI-TSP.16	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.			
MI-VMM.16	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.			
MI-W20.16	Web 2.0	Z,ZK	5
Students will learn new trends and technologies on the Web including theoretical foundations. Students will gain an overview about Web applications architectures, concepts and technologies about programmable Web (REST Architectures, Mashups), basic mechanisms for knowledge representation on the Web (microformats, meta-data, ontologies, open linked data, etc.), mechanisms about collective intelligence (collaborative filtering, predictions of users' behaviours), social networks, and security.			
MI-MDW.16	Web Services and Middleware	Z,ZK	5
Students learn new trends and technologies in the area of service-oriented architectures, web services, middleware, and cloud computing, including their theoretical background.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
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.			

FI-FIL	Philosophy see A0B16	ZK	2
FI-HPZ	Humanities subject from a study abroad	Z	3
A "Humanities subject that has been studied abroad" is covered by the Humanities subject from a study abroad in Compulsory Humanities Module that is required in the curriculum. The substitution is approved by the Vice-Dean for study affairs on behalf of the Dean at the request of the student.			
FI-HTE	History of Technology and Economics	ZK	2
The course introduces the scientific disciplines of history and technology , economic and social history of the Czech lands and Czechoslovakia in comparison with the development of the European region 19 to 21 century .			
FI-KSA	Cultural and Social Anthropology	ZK	2
The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is an interesting alternative to other humanities, taught at FIT.			
FI-MPL	Managerial Psychology	ZK	2
FI-ULI	Introduction to Linguistics for Computer This course is presented in Czech.	ZK	2
FI-VEZ	economic-managerial course from a study abroad	Z	4
A "Humanities subject that has been studied abroad" is covered by the Humanities subject from a study abroad in Compulsory Humanities Module that is required in the curriculum. The substitution is approved by the Vice-Dean for study affairs on behalf of the Dean at the request of the student.			
MI-ADM.16	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).			
MI-ADP.16	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.			
MI-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.			
MI-APH	Architecture of computer games	Z,ZK	4
Students will gain a basic understanding of the various issues in the field of computer game development, from both the technical and creative points of view. They will get a grasp on component-oriented architecture, game mechanics, and game AI 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).			
MI-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.			
MI-ATH	Combinatorial Theories of Games This course is presented in Czech.	Z,ZK	4
MI-AVY	Automata in Text Pattern Matching	Z,ZK	4
Searching in a text (pattern matching) and generally in data is an area of problems and exciting solutions from theoretical and practical perspectives. We may interpret and search the data as one-dimensional (text) or multi-dimensional (tree, picture). We may search for something known (a pattern: a string or a set specified by regular expression) or unknown (for example, a regularity). Matching can be either exact or approximate. This course presents a taxonomy of searching problems. It focuses on algorithms based on some automaton (finite, pushdown, linear-bounded, or tree).			
MI-BHW.16	Security and Hardware	Z,ZK	5
Students gain a basic knowledge in selected topics of cryptography and cruptanalysis. The module focuses particularly on elliptic curve cryptography, and on contemporary attacks on cryptographic systems. Students gain a good overview of the functionality of (hardware) cryptographic accelerators, random number generators, smart cards, and resources for securing of internal functions of computer systems.			
MI-BKO.16	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.			
MI-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.			
MI-BPR	Security and Secure Programming	Z,ZK	4
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.			
MI-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.			
MI-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 (un)solvability of difficult problems.			

MI-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.			
MI-DDW.16	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 and search, 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.			
MI-DIP	Diploma Project	Z	23
MI-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.			
MI-DSP	Database Systems in Practes	Z,ZK	4
This course is presented in Czech.			
MI-DSV.16	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.			
MI-DZO	Digital Image Processing	Z,ZK	4
This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting.			
MI-EDW.16	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.			
MI-FLP	Functional and Logical Programming	Z,ZK	4
Students will be acquainted with principles of functional and logic programming. They will be able to write their programs in Lisp and Prolog programming languages.			
MI-FME.16	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.			
MI-GEN	Code Generators	Z,ZK	4
Students will become acquainted with both theoretical and practical aspects of back-end of an optimizing programming language compiler.			
MI-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.			
MI-HMI2	History of Mathematics and Informatics	ZK	3
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.			
MI-HWB.16	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.			
MI-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).			
MI-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.			
MI-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.			
MI-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).			
MI-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			
MI-KOD.16	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.			

MI-KRY.16	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.			
MI-KYB.16	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).			
MI-LOM.16	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.			
MI-MAI	Multimedia and Internet	Z,ZK	3
The course will cover principles and technologies for processing and network transmissions of multimedia signals, stereoscopy and visualizations in high definition. Lectures will include application areas of networked multimedia, transmission formats, interfaces, codecs, technologies for acquisition and reproduction of multimedia data and technologies for visualizations and distributed collaboration using networking and immersive environments.			
MI-MBI.16	Management of Business Informatics	Z,ZK	5
This course is presented in Czech.			
MI-MCS	Multicore Systems	KZ	4
Students understand architecture of systems based on multicore processors with multiple threads per core, structure and usage of cache hierarchy with shared last level. They learn parallel algorithm classification, parallel programming technics, simulation and monitoring tools for measurement and optimization of parallel algorithms. After this course, students can design MTMD programs (Multiple Threads Multiple Data), measure and analyze latency and throughput of parallel algorithms and optimize them for contemporary multicore systems.			
MI-MDW.16	Web Services and Middleware	Z,ZK	5
Students learn new trends and technologies in the area of service-oriented architectures, web services, middleware, and cloud computing, including their theoretical background.			
MI-MEP.16	Modelling of Business 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.			
MI-MKY.16	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.			
MI-MPC	Modern programming in C ++	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.			
MI-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.			
MI-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.			
MI-MPX	Management practice	Z	4
The Student can once, within its master's degree graduate (to apply) management practices in the selected subject of practice (business subject) on the operational, tactical or strategic level of management (typically at the position of project manager, middle or top manager). The selected subject of practice and professional filling is assessed well in advance the course guarantor. In the selected subject of practice may not have a substantial ownership interest or substantial decision-making influence of the relatives of the student (e.g. as a member of the top management).			
MI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical semantics of programming languages.			
MI-MTI.16	Modern Internet Technologies	Z,ZK	5
Students learn technologies of the modern Internet. links of the IP technology to the modern communication networks, mechanisms for multicasting and real-time communication, more efficient mechanisms of virtual channels, and the new IPv6 architecture. They will understand the issues of monitoring and management of large computer networks. They are introduced to the technologies of interconnection networks for HPC systems.			
MI-MVI.16	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.			
MI-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.			
MI-NFA.16	Design for the FPGA and ASIC Technology	Z,ZK	5
Students gain the basic knowledge needed to start a career in a design house. They will understand the FPGA and ASIC implementation technologies and the limitations that the technologies impose on the design. They are able to perform and to manage typical workflows, their analytic and synthetic steps, with an emphasis on basic verification. They know the structure and demands of software tools, as well as what to expect from them.			
MI-NON.16	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.

MI-NSS.16	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.

MI-NUR.16	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.

MI-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.

MI-PAA	Problems and Algorithms	Z,ZK	5

Students are able to evaluate discrete problems by complexity and by the purpose of optimisation (on-line tasks, multicriterial optimisation). They understand principles and properties of heuristics and exact algorithms and, therefore, are able to select, apply, and experimentally evaluate a suitable heuristics for a practical problem.

MI-PAL	Advanced Algorithms	Z,ZK	4

The students will learn the most important advanced algorithms in different domains of the computer science that are not covered by modules of the Bachelor program Informatics and other modules of the Master program. They will also learn how to cope with problems that, according to the present knowledge, are not solvable optimally in polynomially bounded time.

MI-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.

MI-PAP.16	Parallel Computer Architectures	Z,ZK	5

The students gain a good overview of present parallel architectures and processors:parallel (ILP) microarchitectures, multithreaded and multicore processors, SoCs and MPSoCs, GPUs, and neural processors. Students also get hands-on experience with programming these systems.

MI-PCM.16	Project And Change Management	KZ	3

This course is presented in Czech.

MI-PDB.16	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.

MI-PDD.16	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 parameters from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve a specific problem in individual projects - e.g., parameter extraction from image data or from Internet.

MI-PDP.16	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 multicore and manycore CPUs, parallel and distributed applications are becoming ubiquitous. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks, and languages and environments for parallel programming of shared and distributed memory computers. On selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations.

MI-PIS.16	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.

MI-POA.16	Advanced Computer System Architectures	Z,ZK	5

The student will learn the current trends in infrastructure architecture of complex business computer systems. After completion of the module, the student will be able to design a complex system infrastructure that meets availability and scalability requirements given by the business environment.

MI-PRC	Programming in CUDA	Z,ZK	4

The students gain a good overview of present parallel architectures in GPUs. Students also get hands-on experience with programming these systems.

MI-PSL	Programming in Scala	Z,ZK	4

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

MI-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.		
MI-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.		
MI-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.		
MI-REV.16	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.		
MI-ROZ.16	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.		
MI-RRI	Risk Management in Informatics	ZK	3
	Information security is very often considered as one of main objectives to secure targets of information processing. However, to focus on this info security as a matter of protection of IT systems against viruses, malware etc. very often means misunderstanding and underestimating of real threats which are around us and which are more dangerous then viruses and other malware. The necessity to continue with business after disaster is also slightly ignored. International standards which are focused on informatics and information security just during last years started to anticipate necessity of risk management. There is no commonly accepted methodology used for this task. Threats which are currently possible to see worldwide, invoke pressures to prepare plans for business continuity management even in the case of dramatic political changes, natural disasters etc.		
MI-RUB	Programming in Ruby	KZ	4
	This course is presented in Czech.		
MI-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.		
MI-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.		
MI-SCR	Statistical Analysis of Time Series	Z,ZK	4
	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.		
MI-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.		
MI-SIB.16	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).		
MI-SMI.16	Strategic Management of Informatics	Z,ZK	5
	The course focuses on the strategic management of information systems. Students will learn the process of creation and implementation of an information strategy, IT governance, the importance of ICT for business and interrelations between information strategies and lobal business strategies. Furthermore, they gain the knowledge in the areas of economic management of IS/IT, management of investments and ROI, assessment of IT investments and management of human resources in IT (the role of CIO, CEO, CFO). The part of the course is the role of project management, risk management and quality assessment of informatics.		
MI-SOC.16	Systems on Chip	Z,ZK	5
	Students gain key knowledge and skills in the design of large-scale digital systems. They will be familiar with architectures of such systems and communication among their parts. They will use an appropriate workflow to design these architectures, their hardware and software. They will also have knowledge of contemporary methods of large systems verification and fault-tolerant systems design.		
MI-SPI.16	Statistics for Informatics	Z,ZK	7
	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		
MI-SWE.16	Semantic Web	Z,ZK	5
	Students learn standards used for processing and sharing knowledge mainly in the area of web. They get used to designing and using knowledge models, knowledge representation, and practical aspects as publishing, sharing, exchange, and acquisition of knowledge on the web. The presentation is based on the idea of the semantic web, including its standards and technologies (RDF, RDFS, OWL) and formal models.		
MI-SYB.16	System Security	Z,ZK	5
	Students will familiarize themselves with the actual ICT security needs in all ICT disciplines. Students will gain knowledge of typical network attacks and protection against them, together with essential communication encryption techniques. They will learn how to work with certain aspects of encryption techniques - passwords and certificates. After that, students will		

learn the basics of anti-virus, anti-spam and heuristic analyses used in modern anti-virus solutions or Unified Threat Management (UTM) based solutions. They will also learn the principles of securing websites, web applications and databases. Upon completion of the module, students will have a broad overview of IT security and will be able to apply it to the integration of various software systems and applications.

MI-SYP.16	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.

MI-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).

MI-TES.16	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.

MI-TNN	Theory of Neural Networks	Z,ZK	4

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.

MI-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.

MI-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.

MI-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.

MI-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.

MI-TSP.16	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.

MI-VEM	Scientific thinking	KZ	2

The objective of the course is to get acquainted with scientific methods and discovery of order and laws of the universe, including the aspects of human life. The subject combines scientific methods in natural sciences, mathematics, computer science and humanities. Another aim is to introduce rules and requirements of scientific communication via research papers and posters.

MI-VMM.16	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.

MI-VYC	Computability	Z,ZK	4

Classical theory of recursive functions and effective computability, with applications in provability theory.

MI-W20.16	Web 2.0	Z,ZK	5

Students will learn new trends and technologies on the Web including theoretical foundations. Students will gain an overview about Web applications architectures, concepts and technologies about programmable Web (REST Architectures, Mashups), basic mechanisms for knowledge representation on the Web (microformats, meta-data, ontologies, open linked data, etc.), mechanisms about collective intelligence (collaborative filtering, predictions of users' behaviours), social networks, and security.

MI-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.

MI-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.			
MI-ZS30	Master internship abroad for 30 credits	Z	30
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-AML	Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of recommendation systems, image processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed.			
NI-CAP	Cultural and Social Anthropology	ZK	2
The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is presented in Czech.			
NI-CCC	Creative Coding and Computational Art	KZ	4
Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,…) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL).			
NI-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-IAM	Internet and Multimedia	Z,ZK	4
The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquisition of AV signals (input), presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical use case scenarios of real-time audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation for audience.			
NI-LSM	Statistical Modelling Lab	KZ	5
The subject is oriented on a single and multi-target tracking. The student both learns the existing methods and tries to implement them. The stress is put on the effective use of the available information and its modeling using numpy and scipy. The second half of the semester is focused on the design of methods and algorithms, and analyses of their properties. At this point, the subject is on the border of own research and may result in the topic of final work (diploma or bachelor thesis).			
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-PG1	Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics.			
NI-VPR	Research Project	Z	5
Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.			
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
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