Study plan

Name of study plan: Master specialization System Programming, in Czech, version from 2020

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch: Program of study: Informatika

Type of study: Follow-up master full-time

Required credits: 98

Elective courses credits: 22 Sum of credits in the plan: 120

Note on the plan: Tato verze studijního plánu je ur ena pro ro níky, které byly p ijaty ke studiu od akademického roku 2020/2021 do prezen ní formy studia magisterského programu. . Garant: doc. lng. Jan

Janoušek, Ph.D., email: jan.janousek@fit.cvut.cz

Name of the block: Compulsory courses in the program

Minimal number of credits of the block: 63

The role of the block: PP

Code of the group: NI-PP.2020

Name of the group: Compulsory Courses of Master Study Program, Version 2020, in Czech

Requirement credits in the group: In this group you have to gain 63 credits

Requirement courses in the group: In this group you have to complete 6 courses

Credits in the group: 63 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-DIP	Diploma Thesis Zden k Muziká Zden k Muziká Zden k Muziká (Gar.)	Z	30	270ZP	L,Z	PP
NI-KOP	Combinatorial Optimization Jan Schmidt, Ji í Vysko il, Petr Fišer Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	6	2P+2C	Z	PP
NI-MPR	Master Project Zden k Muziká Zden k Muziká (Gar.)	Z	7		Z,L	PP
NI-MPI	Mathematics for Informatics Št pán Starosta, Jan Sp vák Št pán Starosta Št pán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NI-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík (Gar.)	Z,ZK	6	2P+2C	L	PP
NI-VSM	Selected statistical Methods Jitka Hrabáková, Petr Novák, Daniel Vašata, Ivo Petr, Pavel Hrabák, Jana Vacková Pavel Hrabák Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

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

NI-DIP	Diploma Thesis	Z	30					
NI-KOP	Combinatorial Optimization	Z,ZK	6					
The students will gain k	The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but							
also to apply and evalua	also to apply and evaluate heuristics for practical problems.							
NI-MPR	Master Project	Z	7					
4			the constant and					

^{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. The external supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/student/studijni/formulare). The completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 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.

approvable at the end of the semester.

NI-MPI Mathematics for Informatics
The course comprises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analysis, smooth optimization and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic includes selected numerical

algorithm and their stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear presentation and argumentation.

NI-PDP Parallel and Distributed Programming

,ZK

6

21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Parallel computing systems are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course includes a semester project of practical programming in OpenMP and MPI for solving a particular nontrivial problem.

NI-VSM Selected statistical Methods

Z,ZK

7

The course leads the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with multivariate normal distribution, application of entropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random processes with focus on Markov chains. The high point of the course is the Queuing theory and its application in networks.

Name of the block: Compulsory courses in the specialization

Minimal number of credits of the block: 35

The role of the block: PS

Code of the group: NI-PS-SP.20

Name of the group: Compulsory Courses of Master Specialization System Programming, v.2020, in Czech

Requirement credits in the group: In this group you have to gain 35 credits

Requirement courses in the group: In this group you have to complete 7 courses

Credits in the group: 35 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and quarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-GEN	Code Generators Petr Máj, Jan Janoušek Petr Máj Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-MPJ	Modelling of Programming Languages	Z,ZK	5	2P+1C	Z	PS
NI-OSY	Operating Systems and Systems Programming Petr Zemánek, Tomáš Martinec Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-RUN	Runtime Systems Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NI-PS-SP.20 Name=Compulsory Courses of Master Specialization System Programming, v.2020, in Czech

NI-EPC | Effective C++ programming | Z,ZK | 5
Students learn how to use the modern features of contemporary versions of the C++ programming language for software development. The course focuses on programming effectivity and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time requirements.

NI-GEN Code Generators Z,ZK 5

Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of systems programming. This primarily involves understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming. Students will become familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.

NI-MPJ | Modelling of Programming Languages | Z,ZK | 5

The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve the semantics of the language. This course explores the semantics of programming languages. The students will learn the language models with emphasis on functional languages, students are expected to understand the basics of the lambda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with semantic modeling and execution tools.

NI-OSY Operating Systems and Systems Programming Z,ZK 5

The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel data structures. Key topics are: process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The course also addresses kernel development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. Specifics of kernel architecture in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, students will work on projects focused on development of LINUX kernel modules.

NI-RUN Runtime Systems Z,ZK 5

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

NI-SYP Parsing and Compilers Z,ZK 5

The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.

NI-APR Selected Methods for Program Analysis

This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.

Name of the block: Elective courses Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NI-V.2021

Name of the group: Purely Elective Master Courses

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 b	e re-comple	ted.			
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-AOA	Completing a professional event Zden k Muziká	Z	1			V
NI-ATH	AlgorithmicTheories of Games Dušan Knop, Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+2C	L	V
NI-AFP	Applied Functional Programming Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl (Gar.)	KZ	5	2P+1C	L	V
NI-APH	Architecture of computer games Adam Vesecký Adam Vesecký Adam Vesecký (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-VGA	Video Games Architecture Jan Matoušek	Z,ZK	5	2P+1C	z	V
NI-BPS	Wireless Computer Networks Ji í Kašpar, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-BLO	Blockchain Róbert Lórencz, Jakub R ži ka, Josef Gattermayer, Marek Bielik Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-CTF	Capture The Flag Ji í Dostál, Martin Šutovský, Ivana Trummová, Ladislav Marko, František Ková Ji í Dostál Ji í Dostál (Gar.)	KZ	4	3C	Z	V
NI-DPH	Game Design Adam Vesecký	Z,ZK	5	2P+1C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-PSD	Public Services Design Ond ej Brém, David Pešek David Pešek Ond ej Brém (Gar.)	KZ	4	1P+2C		V
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná Denisa Nová ková Denisa Nová ková (Gar.)	Z	2	4C	Z,L	V
NI-DZO	Digital Image Processing	Z,ZK	4	2P+1C	L	V
NI-DDM	Distributed Data Mining Tomáš Borovi ka	KZ	4	3C	L	V
NI-PAM	Efficient Preprocessing and Parameterized Algorithms Ond ej Suchý Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-ESC	Experimental Project Course Jan Matoušek, Ond ej Brém Ond ej Brém Ond ej Brém (Gar.)	KZ	8	0P+30R+52C	L	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GNN	Graph Neural Networks Miroslav epek Miroslav epek (Gar.)	Z,ZK	4	1P+1C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler Pavel Tvrdík André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-HCM	Mind Hacking Marcel Ji ina, Josef Holý Marcel Ji ina Marcel Ji ina (Gar.)	ZK	5	2P+1C	Z	V
NI-HSC	Side-Channel Analysis in Hardware Vojt ch Miškovský, Petr Socha Petr Socha Vojt ch Miškovský (Gar.)	Z,ZK	4	2P+2C	Z	V
NI-HMI2	History of Mathematics and Informatics Alena Šolcová Alena Šolcová Alena Šolcová (Gar.)	ZK	3	2P+1C	Z	V
NI-IBE	Information Security Igor ermák	ZK	2	2P	Z	V

NI-IVS	Intelligent embedded systems Miroslav Skrbek Miroslav Skrbek (Gar.)	KZ	4	1P+3C	L	V
NI-IKM	Internet and Classification Methods Martin Hole a Martin Hole a Martin Hole a (Gar.)	Z,ZK	4	1P+1C	L	V
NI-IAM	Internet and Multimedia	Z,ZK	4	2P+1C	L	V
NI-IOT	Internet of Things Jan Jane ek	Z,ZK	4	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan	Z,ZK	3	2P+1C	L	V
NI-KTH	Combinatorial Theories of Games Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+1C	L	V
NI-FMT	Finite model theory Tomáš Jakl Tomáš Jakl (Gar.)	Z,ZK	4	2P+1C	L	V
NI-CCC	Creative Coding and Computational Art Radek Richtr, Josef Kortán Radek Richtr (Gar.)	KZ	4	1P+2C	Z,L	V
NI-KYB	Cybernality	ZK	5	2P	Z	V
NI-LSM2	Statistical Modelling Lab Kamil Dedecius Kamil Dedecius (Gar.)	KZ	5	3C	Z,L	V
NI-LOM	Linear Optimization and Methods Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPL	Managerial Psychology Jan Fiala Jan Fiala (Gar.)	ZK	2	2P	Z,L	V
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4	2P+1C	L	V
NI-MZI	Mathematics for data science Št pán Starosta	Z,ZK	4	2P+1C	L	V
FIT-ITI	Modern IT infrastructure Ivan Sime ek	Z,ZK	5	2P+1C	Z,L	V
NI-MOP	Modern Object-Oriented Programming in Pharo Jan Blizni enko Robert Pergl Robert Pergl (Gar.)	KZ	4	3C	Z	V
NI-NLM	Neural Language Models	Z	5	2P+1C	L	V
NI-NMS	Neural Networks, Machine Learning and Randomness Martin Hole a	Z,ZK	4	1P+1C	Z	V
NI-NMU	New media in art and design Zden k Svejkovský Zden k Svejkovský (Gar.)	ZK	3	2P+0C	Z	V
NI-OLI	Linux Drivers Jaroslav Borecký, Miroslav Skrbek Jaroslav Borecký Miroslav Skrbek (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-PML	Personalized Machine Learning Rodrigo Augusto Da Silva Alves Karel Klouda Rodrigo Augusto Da Silva Alves (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík Alois Pluhá ek (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-PG1	Computer Grafics 1 Radek Richtr Radek Richtr (Gar.)	ZK	4	2P+1C	L	V
NI-PIV	Computer Vision Radek Richtr	Z,ZK	5	2P+2C	Z	V
NI-EDW	Enterprise Data Warehouse Systems Jakub Krej í, Robert Kotlá Jakub Krej í Magda Friedjungová (Gar.)	Z,ZK	5	1P+1C	L	V
NI-PVR	Advanced Virtual Reality Petr Pauš Petr Pauš Petr Pauš (Gar.)	KZ	4	2P+1C	Z	V
NI-AML	Advanced machine learning Zden k Buk, Miroslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimánek, Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)	Z,ZK	5	2P + 1C	L	V
NI-IOS	Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)	KZ	4	2P+2C	L	V
NI-APT	Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PVS	Advanced embedded systems Miroslav Skrbek	Z,ZK	4	2P+2C	Z	V
NI-DNP	Advanced .NET David Šenký , Nikolas Jíša David Šenký Nikolas Jíša (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-PYT	Advanced Python Miroslav Hron ok	KZ	4	3C	Z	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)	KZ	5	2P+1C	Z	V
FIT-ACM1	Programming Practices 1 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM2	Programming Practices 2 Ond ej Suchý	KZ	5	4C	Z	V
FIT-ACM3	Programming Practices 3 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM4	Programming Practices 4 Ond ej Suchý	KZ	5	4C	Z	V

FIT-ACM5	Programming Practices 5 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM6	Programming Practices 6 Ond ej Suchý	KZ	5	4C	L	V
NI-GOL	Programming of distributed systems in GO	KZ	5	0P+3C	Z	V
NI-PSL	Programming in Scala Ji í Dan ek Ji í Dan ek Ji í Dan ek (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-RUB	Programming in Ruby Cyril erný Cyril erný (Gar.)	KZ	4	3C	Z	V
NI-ROZ	Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PLS4	Programming Language Seminar Pierre Donat-Bouillud, Filip K ikava Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z	2	0P+1C	L	V
NI-PLS3	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	Z	V
NI-PLS2	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	L	V
NI-PLS1	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	Z	V
NI-SCE1	Computer Engineering Seminar Master I Hana Kubátová Miroslav Skrbek Hana Kubátová (Gar.)	Z	4	2C	L,Z	V
NI-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L,Z	V
NI-SZ1	Knowledge Engineering Seminar Master I Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	V
NI-SZ2	Knowledge Engineering Seminar Master II Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	V
PI-SCN	Seminars on Digital Design Petr Fišer Petr Fišer (Gar.)	ZK	4	2P+1C	Z,L	V
NI-MLP	Machine Learning in Practice Jan Hu in Daniel Vašata Daniel Vašata (Gar.)	Z,ZK	5	2P+1C	Z	V
FIT-SEP	World Economy and Business Tomáš Evan	Z,ZK	4	2P+2C	L	V
NI-SEP	World Economy and Business Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-TVR	Virtual Reality Technology Tomáš Nová ek Tomáš Nová ek (Gar.)	Z,ZK	3	1P+1C	L,Z	V
NI-TS1	Theoretical Seminar Master I Dušan Knop, Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	V
NI-TS2	Theoretical Seminar Master II Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	L	V
NI-TS3	Theoretical Seminar Master III Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	V
NI-TS4	Theoretical Seminar Master IV Ond ej Suchý, Tomáš Valla Tomáš Valla Ond ej Suchý (Gar.)	Z	4	2C	L	V
NI-TKA	Category Theory Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-TNN	Theory of Neural Networks Martin Hole a Martin Hole a Martin Hole a (Gar.)	Z,ZK	5	2P+1C	L	V
NI-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	V
FI-TOP	Academic writing Tomáš Nová ek	Z	2	10B	Z	V
NI-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VOL	Elections Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NI-VPR	Research Project Št pán Starosta Št pán Starosta (Gar.)	Z	5		Z,L	V
NI-ZS10	Master internship abroad for 10 credits Zden k Muziká Zden k Muziká (Gar.)	Z	10		Z,L	V
NI-ZS20	Master internship abroad for 20 credits Zden k Muziká Zden k Muziká (Gar.)	Z	20		Z,L	V
NI-ZS30	Master internship abroad for 30 credits Zden k Muziká Zden k Muziká (Gar.)	Z	30		Z,L	V

Characteristics of the courses of this group of Study Plan: Code=NI-V.2021 Name=Purely Elective Master Courses

NI-AOA Completing a professional event

The subject is participation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafting a report, etc.Such an event must be approved in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT through a website, informail, etc.

NI-ATH AlgorithmicTheories of Games		Z,ZK	4
Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and compute (players) of a certain competitive process by designing a mathematical model and investigating the strategies. The tradition			_
which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of compu	-	-	•
multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions	we study the problems of	f efficient computa	ation of various
solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibrian and a solution concept).	a) and methods of their of		
NI-AFP Applied Functional Programming This serves is presented in Creek Functional arguments are at the traditional programming personnel and of the traditional programming personnel arguments.	itianal and naval function	KZ	5
This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Tradit the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++,			
necessary competence of a software engineer: the theory and especially the practice.	O#, 00va). 713 30011, 11103	itering this paradig	Jili becomes a
NI-APH Architecture of computer games		Z,ZK	4
Students will gain a basic understanding of the various issues in the field of computer games development, especially from a te	•	-	
perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-ma	• .	•	•
part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practice implementation of a simple game, with a strong focus on nontrivial game mechanics.	al exercises (labs). An im	portant part of the	e course is an
NI-VGA Video Games Architecture		Z,ZK	5
The course covers a wide range of topics, procedures and methodologies related to the development of computer games -	from a technical point of		_
philosophical point of view. In the lectures, students will be guided through the history of development, the structure of game	e engines, component an	nd functional archi	tecture typical of
game development, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technolog	ical topics in greater deta	ail, including ways	of implementing
some game mechanics, in the form of practical demonstrations.		7.71/	
NI-BPS Wireless Computer Networks Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the	routing machanisms in	Z,ZK	4
broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in senso	•		
for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using	· ·		
NIE-BLO Blockchain		Z,ZK	5
Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of mo	st notable blockchain pla	tforms. They will b	e able to design,
code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given p	•		= -
relationship between blockchains and information security. It is concluded with a defense of a research or applied semester supervising implementation of blockchain-based solutions in both academia and business.	project, which prepares	the students for in	nplementing or
NI-CTF Capture The Flag		KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber	er security.	1\2	4
NI-DPH Game Design		Z,ZK	5
The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while	focusing primarily on gan		ended for people
interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character			
development cycle. The students will get an overview of game development from the designer's perspective, from theoretical	I concepts to practical im	plementation app	lied to semestral
NI-DSW Design Sprint		Z	2
Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are a	able to go from idea to va		_
the course the students will get familiar with the method as participants. Through practical challenges they will try the whole	•		, ,
testing the prototypes (plus final presentation).			
NI-PSD Public Services Design		KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the	•	•	•
suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations a Course is aimed at students-designers as well as clients.	ind will try out collaborati	on with client repr	esenialives.
NI-DID Digital drawing		Z	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain underst	anding of composition, pe		_
they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital a	_	-	e who wants to
practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practic	al exercise to practice ga	<u>_</u>	
NI-DZO Digital Image Processing This source process a comprehensive everyion of modern methods for intersective editing of digital images and video. It may	ainly doolo with prooficely	Z,ZK	4
This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It may implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical basis.		-	-
of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware ed	•		
frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-			
interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation	, colorization, painting, a		
NI-DDM Distributed Data Mining	0	KZ	4
Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithm data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of the	-		-
approaches to parallelize other algorithms. The course is prezented in czech language.	ii paraliei iiripieriieritatiori	is and will be cape	able to propose
NI-PAM Efficient Preprocessing and Parameterized Algorithms		Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). De	spite that it is often nece	1 ' 1	se problems
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all p			
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the noti			
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whateve			-
plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and param	•		•
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or app	roximation schemes.		
NI-ESC Experimental Project Course		KZ	8
"The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded under		_	
in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will v experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, stud	=		=
user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."	onto will develop their SK	o III uoci-Celilele	ou ucaiyii dilu
NI-GLR Games and reinforcement learning		Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks an	ıd general artificial intelliç		
give you both theoretical and practical background so you can participate in related research activities. Presented in English	١.		

NI-GNN Graph Neural Networks	Z,ZK	. 4
The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last		-
graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.	part of the course	also covers
NI-GRI Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.	_, ,	Ū
NI-HCM Mind Hacking	ZK	5
Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks,	information syster	ms and assets,
the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive se	, , ,	•
the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Inter	net environment h	ave real societal
impacts such as disruption of social cohesion, threats to democracy or war.	7 71/	4
NI-HSC Side-Channel Analysis in Hardware This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical atta	Z,ZK	4 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 at	-	
attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel inform	_	g
NI-HMI2 History of Mathematics and Informatics	ZK	3
This course is presented in Czech. Selected topics (Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithm	ms, transformation	s, recursive
functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development.		
NI-IBE Information Security	ZK	2
Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internal		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., pen		4
NI-IVS Intelligent embedded systems	KZ	4
Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. To the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot progra		
development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, stude	-	
combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies	·	
NI-IKM Internet and Classification Methods	Z,ZK	4
In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filte	ring, in recommen	dation systems,
in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving	•	•
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		ures 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 the		4
NI-IAM Internet and Multimedia The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes a	Z,ZK	anals (innut)
presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practic		
audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the		
the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recordin		
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for audience.	y the scene up to	ano procentation
for audience. NI-IOT Internet of Things	Z,ZK	4
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NI-LOM	Linear Optimization and Methods	Z,ZK	5
1	ications of optimization methods in computer science, economics, and industry. They are aware of practical importance of line		
	otimization software and are familiar with languages used in programming of that software. They get skills in formalization of course of tracks to programs, applying of pathyrish flows), distribution and allocation of recourses (tracks proportion problems, tracks to programs, applying of pathyrish flows), distribution and allocation of recourses (tracks proportion problems, tracks to programs).		
· ·	uling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travand modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems.	-	
in linear programming.	and modeling of common to the model of model, they got an ever field of competence of	mo, got onoman	on algerianie
NI-MPL	Managerial Psychology	ZK	2
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
	s of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Sco	tt model of lambda	a calculus.
Introduction to category		7 714	
NI-MZI	Mathematics for data science are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in	Z,ZK	4
· ·	gebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality prin		•
selected notions from p	robability theory and statistics.		•
FIT-ITI	Modern IT infrastructure	Z,ZK	5
· ·	ime-invariable range of software or hardware, this subject tries to explain the issue as a whole and in the context of the time. A		
	complex whole, the individual parts of which must be reconciled from different aspects of the view using current technologie inuous and economically optimal operation.	s. The proposed s	solution snould
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
_	nming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, wh		= = = = = = = = = = = = = = = = = = = =
· ·	modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the s	_	
, ,	dern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their developmen		
	bject programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to wo f semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involv		-
NI-NLM	Neural Language Models	7	5
	will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models	. – ,	-
	guage models to solve problems, make informed risk assessments, and work critically with the scientific literature.		
NI-NMS	Neural Networks, Machine Learning and Randomness	Z,ZK	4
	methods based on randomness, are extremely important for the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of the const		- 1
	eural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural netwo a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the gene	· · · · · · · · · · · · · · · · · · ·	-
	ows that, in addition to the use of randomness in neural networks and machine learning, in the linal two topics, it explains the gene ows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including		- 1
	pplications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms.		
NI-NMU	New media in art and design	ZK	3
	students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game		_
	vith the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especia	ally in lectures dev	oted to specific
art projects.	Linux Drivers	7 7K	4
NI-OLI	Linux Drivers stem is an important operating system for personal computer and also for embedded systems. Systems on chip and combining	Z,ZK g powerful process	4 sors and FPGAs
NI-OLI The Linux operating sys	rstem is an important operating system for personal computer and also for embedded systems. Systems on chip and combining of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development.	g powerful process ent for master's st	sors and FPGAs
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NI-APT Advanced Program Testing	Z,ZK	5
Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The	ne goal of the course	is to present
advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.		
NI-PVS Advanced embedded systems	Z,ZK	4
The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of adv		curity support.
working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also pra	•	
systems.		
NI-DNP Advanced .NET	Z,ZK	4
Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAI		
get notions of Azure DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application ut Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.	ilizing technologies /	ASP.NET COIE,
	1/7	4
NI-PYT Advanced Python	KZ	4
The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python.		
very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral course	ework. The course is	lead by external
teachers from Red Hat.		
NIE-PDL Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machin	ne learning framewor	rk. Throughout
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields	such as computer vi	ision and natural
language processing.		
FIT-ACM1 Programming Practices 1	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM2 Programming Practices 2	KZ	5
	I IXZ	3
This is a selective course for preparing talented student for representation in international programming contests.	1/7	
FIT-ACM3 Programming Practices 3	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM4 Programming Practices 4	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM5 Programming Practices 5	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.		
	KZ	5
	KZ	3
This is a selective course for preparing talented student for representation in international programming contests.		
NI-GOL Programming of distributed systems in GO	KZ	5
NI-PSL Programming in Scala	Z,ZK	4
The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language for	eatures - 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 framewor	ks and libraries e.g. F	Play, Cassandra,
Cooley etc		
Scalaz, etc.		
	K7	4
NI-RUB Programming in Ruby	KZ	4
NI-RUB Programming in Ruby This course is presented in Czech.	'	
NI-RUB Programming in Ruby This course is presented in Czech. NI-ROZ Pattern Recognition	Z,ZK	5
NI-RUB Programming in Ruby This course is presented in Czech. NI-ROZ Pattern Recognition 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	Z,ZK e statistical approact	5 h to pattern
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NI-RUB Programming in Ruby This course is presented in Czech. NI-ROZ Pattern Recognition 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 recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, NI-PLS4 Programming Language Seminar	Z,ZK e statistical approacl and their numerical	5 h to pattern aspects.
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NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
· · · · · · · · · · · · · · · · · · ·	present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research property and read existific papers. The work in the appropriate the attention of the property and the adversarial property and the adversarial property and the adversarial property.		
	'n how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top ma s well as FIT's own Summer Research Program (VyLet).	ichine learning and	Al conletences
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		and basic logic
	ion algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial programme and the combinatorial programme are given, together with combinatorial programme and the combinatorial programme are given.	problems emergin	g in EDA.
NI-MLP	Machine Learning in Practice	Z,ZK	5
	ing methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to ents through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practic		
_	arn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and unc	-	
FIT-SEP	World Economy and Business	Z,ZK	4
This course is presente	d in Czech. The course introduces students of technical university to the international business. It does that predominantly by	comparing individual	dual countries
· -	l economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well		
•	c development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form on take bachelor level of this course BIE-SEP as a prerequisite.	of discussions das	ed on individual
NI-SEP	World Economy and Business	Z,ZK	4
_	d in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of	. , ,	
	t does that predominantly by comparing individual countries and key regions of world economy. Students get to know about of	Ü	′
-	iness in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed	-	
NI-TVR	ve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course		erequisite.
	Virtual Reality Technology ced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of or	Z,ZK	_
	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of	_	
reality will be presented	<u> </u>		
NI-TS1	Theoretical Seminar Master I	Z	4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		•
· · · · · · · · · · · · · · · · · · ·	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a. The capacity is limited by the the potentials of the teachers of the seminar.	s a work with scier	illiic papers and
NI-TS2	Theoretical Seminar Master II	Z	4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class	ssical reading grou	up. The students
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	s a work with scier	ntific papers and
	e. The capacity is limited by the the potentials of the teachers of the seminar.	-	
NI-TS3	Theoretical Seminar Master III ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a clas-	Z Z	4 In The students
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		•
		3 a WOLK WILL SOICE	
other scholarly literature	e. The capacity is limited by the the potentials of the teachers of the seminar.	3 a Work With Soloi	nino paporo ana
NI-TS4	e. The capacity is limited by the the potentials of the teachers of the seminar. Theoretical Seminar Master IV	Z	4
NI-TS4 Theoretical seminar is in	e. The capacity is limited by the the potentials of the teachers of the seminar. Theoretical Seminar Master IV Intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class	Z ssical reading grou	4 up. The students
NI-TS4 Theoretical seminar is in are treated individually a	a. The capacity is limited by the the potentials of the teachers of the seminar. Theoretical Seminar Master IV Intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	Z ssical reading grou	4 up. The students
NI-TS4 Theoretical seminar is in are treated individually a other scholarly literature	a. The capacity is limited by the the potentials of the teachers of the seminar. Theoretical Seminar Master IV Intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a. The capacity is limited by the the potentials of the teachers of the seminar.	Z ssical reading grous a work with scier	4 up. The students
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NI-VYC	Computability	Z,ZK	4
Classical theory of rec	ursive functions and effective computability.	•	
NI-VPR	Research Project	Z	5
Student obtains the cre	edits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.	'	'
NI-ZS10	Master internship abroad for 10 credits	Z	10

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

NI-ZS20 Master internship abroad for 20 credits

| 2

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

NI-ZS30 Master internship abroad for 30 credits

30

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

Code of the group: NI-SP-VS.20

Name of the group: Elective Vocational Courses for Master Specialization System Programming

Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

Note on the group:

Povinné předměty všech specializací s výjimkou této specializace.

Note on the group): Povinine predinety vsecii speci	alizaci s vyji	ilikou le	io specia	alizace.	
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-ADM	Data Mining Algorithms Pavel Kordík, Daniel Vašata, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz, Olha Jure ková Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ADP	Architecture and Design patterns Filip K ikava, Jan Kurš, Jan Zimolka, Tomáš Chvosta, Ji í Borský Jan Kurš Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	٧
NI-AM1	Middleware Architectures 1 Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM2	Middleware Architectures 2 Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	L	V
NI-BML	Bayesian Methods for Machine Learning Ond ej Tichý, Kamil Dedecius Ond ej Tichý, Kamil Dedecius (Gar.)	KZ	5	2P+1C	L	V
NI-BVS	Embedded Security Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NI-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-DSV	Distributed Systems and Computing Pavel Tvrdík Jan Fesl Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DDW	Web Data Mining Jaroslav Kucha, Milan Doj inovski Jaroslav Kucha Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	V
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	V
NI-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V
NI-HWB	Hardware Security Jií Bu ek Jií Bu ek Jií Bu ek (Gar.)	Z,ZK	5	2P+2C	L	V
NI-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NI-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	V
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MEP	Modelling of Enterprise Processes Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V

	Modern Internet Technologies					
NI-MTI	Viktor erný, Alexandru Moucha Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	V
NI-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek, Jan Verelst Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	V
NI-BUI	Business Informatics Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	V
NI-PIS	Enterprise Information Systems Vlastimil Jinoch, Martin Závrbský, Martin Mach, Martin Hasaj David Buchtela David Buchtela (Gar.)	Z,ZK	5	2P+1C	L	V
NI-KRY	Advanced Cryptology Ji í Bu ek, Róbert Lórencz Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-PAS	Advanced Aspects of Business David Buchtela, St pánka Havlíková, Dominik Vítek, Ji í Maršál, Jana Soukupová, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-PDB	Advanced Database Systems Yelena Trofimova, Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PDD	Data Preprocessing Marcel Ji ina Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-REV	Reverse Engineering Josef Kokeš Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski, Jakub Klímek Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SIB	Network Security Ji í Dostál, Simona Forn sek, Martin Šutovský, Martin Holec Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SCR	Statistical Analysis of Time Series Kamil Dedecius Kamil Dedecius (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SBF	System Security and Forensics Simona Forn sek, Marián Svetlík Simona Forn sek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl, David Buchtela David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TES	Systems Theory Ji í Vysko il, Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TSP	Testing and Reliability Petr Fišer Martin Da hel Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-TSW	Software Product Development Petra Pavlí ková Petra Pavlí ková Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	V
NI-UMI	Artificial intelligence Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PON	Selected Topics in Optimization and Numerical mathematics Karel Klouda, Št pán Starosta, Daniel Vašata Daniel Vašata Št pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VMM	Retrieval from Multimedia Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V

Characteristics of the courses of this group of Study Plan: Code=NI-SP-VS.20 Name=Elective Vocational Courses for Master Specialization System Programming

<u> </u>	<u> </u>		
NI-SYP	Parsing and Compilers	Z,ZK	5
The module builds upon	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of	of various variants	and applications
of LR parsing and are in	ntroduced to special applications of parsers, such as incremental and parallel parsing.		
NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses on	algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the stude	nts should know n	nachine learning
basics. The emphasis is	put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation and the state of the stat	systems) and mod	dels (e.g., kernel
mothods)			

NI-AIB	Algorithms of Information Security	Z,ZK	5
Students will get acquair	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, st	udents will learn th	ne mathematical
principles of cryptograpl	hic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware determined to the course is defined to the course of the course is determined to the course of the cours	ction and the use	of machine
learning in detection sys	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.		
NI-ADP	Architecture and Design patterns	Z,ZK	5
The objective of this cou	urse is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis	as well as with u	nderstanding of
the challenges, issues, a	and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledg	e of object-oriente	ed programming
and get familiar with the	commonly used object-oriented design patterns that represent the best practices for solving common software design problem	ns. In the second p	art the students
will be introduced to the	principles of software architecture design and analysis. This includes the classical architectural styles, component based syste	ms, and some adv	anced software
architectures used in lar	ge-scale distributed systems.		
NI-AM1	Middleware Architectures 1	Z,ZK	5
Students will study new	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information sys	tem architecture,	web service
architecture and aplication	on servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	I high availability
of applications.			
NI-AM2	Middleware Architectures 2	Z,ZK	5
Students will learn new	trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architec	tures, concepts ar	nd technologies
for microservices, distru	buted cache and databases, smart contracts, realtime communication and web security.		
NI-BML	Bayesian Methods for Machine Learning	KZ	5
The subject is focused of	n practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studi	es the constructio	n of appropriate
models providing descri	ption of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidder	n variables (true c	bject 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	g. The students wi	Il try to solve
some of them.			
NI-BVS	Embedded Security	Z,ZK	5
Students gain basic know	wledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cry	yptographic primit	ves in hardware
and software (in embedo	ded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resour	ces for securing ir	nternal functions
of computer systems.			
NI-BKO	Error Control Codes	Z,ZK	5
The goal of the course is	s to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted vi	a channels.	
NI-DSV	Distributed Systems and Computing	Z,ZK	5
- 1	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of comput		-
	sic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms th		
	safety in case of failures.		
NI-DDW	Web Data Mining	Z,ZK	5
	t methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain		-
	ling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an over		-
•	and recommendation systems.		
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
	of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acc		-
	the knowledge in design of applications that utilize pattern matching.		.,,.
NI-FME	Formal Methods and Specifications	Z,ZK	5
	scribe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some		
basic properties of softw	,		
NI-GAK	Graph theory and combinatorics	Z,ZK	5
	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithm		
•	sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected	•	
	y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theor		
	ds, formal languages and bioinformatics.	,	
NI-HWB	Hardware Security	Z,ZK	5
	e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegua		
•	They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stud	_	-
-	erators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the co	_	
NI-KOD	Data Compression	Z,ZK	5
	to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data		
	erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, st	•	- 1
•	methods used in image, audio, and video compression.		
	Mathematics for Cryptology	Z,ZK	5
	er knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.	·	
	g a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discre		
•	solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NI-MVI	Computational Intelligence Methods	Z,ZK	5
	d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to		
	k and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.		,
NI-MEP	Modelling of Enterprise Processes	Z,ZK	5
	on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach	·	
	esses, organisation structures and information support in big enterprises and institutions.	() 5.19.11001	3 · · ·
NI-MTI	Modern Internet Technologies	Z,ZK	5
	"Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration		
-	whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, vid	-	
= = = = = = = = = = = = = = = = = = = =	design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundred		
-	s a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and		
	ce providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela		
-	es - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of fi		

A III A III I ID			
NI-NUR Students will understand	User Interface Design the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, for	Z,ZK	5
	. They get acquainted with graphical, speech, and multimodal Uls. Thanks to the gained knowledge, the students will be able		
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
_	ced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods	,	-
	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The		
	ns that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implemen	•	
as well as in parallel.		· ·	. ,
NI-NSS	Normalized Software Systems	ZK	5
Students will learn the f	oundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineer	ing, such as stabi	lity from system
theory and entropy from	thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related is	sues occur in any	given software
	and part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements.		
•	on systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stabi	lity and entropy-re	lated principles.
	students to realize new levels of evolvability in software architectures.		
NI-BUI	Business Informatics	Z,ZK	5
	to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of	-	-
	ectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manager	=	-
	ource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governal	•	
	ct of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manageme ment evaluation and human resources management in IT (roles CIO, CEO, CFO).	nt, revenue and ir	ivesiment
NI-PIS	Enterprise Information Systems	Z.ZK	5
	Enterprise information Systems in the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage o	-,	-
	nce). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication		
· -	nore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the l		
· · · · · · · · · · · · · · · · · · ·	nted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and opera		
company / organization			,
NI-KRY	Advanced Cryptology	Z,ZK	5
	essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know	, ,	-
	tors. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they		
their own systems or to	the creation of their own software solutions.		
NI-PAS	Advanced Aspects of Business	Z,ZK	4
The aim of the course is	s to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run th	neir own business	or business
management, especially	y in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.		
NI-PDB	Advanced Database Systems	Z,ZK	5
Students orient themse	ves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of datab	ase machines (so	called NoSQL
databases), with the rel	ated new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CY	PHER, Gremlin).	The last part of
the course deals with pe	erformance evaluation of database machines.		
NI-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain know			
•	edge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the G		
which is already a wides	pread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical c		
which is already a wides will also learn optimizat	pread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical con programming techniques and methods of programming multiprocessor GPU systems.	computational stru	ctures, students
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NI-TES Systems Theory 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. Testing and Reliability NI-TSP Z,ZK Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with built-in-self-test equipment. They will be able to compute, analyze, and control the reliability and availability of the designed circuits. NI-TSW Software Product Development ΚZ 4 The course is presented in Czech. NI-UMI Artificial intelligence Z.ZK 5 The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated. NI-EHW **Embedded Hardware** Z,ZK 5 The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures. **Embedded Software** NI-ESW Z,ZK 5 Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence. NI-VCC Virtualization and Cloud Computing Z,ZK Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development). Selected Topics in Optimization and Numerical mathematics NI-PON Z.ZK The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-VMM Retrieval from Multimedia Z,ZK The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines. NI-MCC Multicore CPU Computing

Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.

List of courses of this pass:

Code	Name of the course	Completion	Credits
FI-TOP	Academic writing	Z	2
Publishing is an importa	nt and required part of research activity. It is not only about obtaining research results but also about applying them in the form	of publication. Writi	ng scientifi
publications can be use	ful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the cou	ırse, students will le	earn how to
write a scientific article, v	what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an	article and reviewing	ng someon
else's article. The cours	e will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. D	ates will be determ	ined based
	on the availability of enrolled students.		
FIT-ACM1	Programming Practices 1	KZ	5
'	This is a selective course for preparing talented student for representation in international programming contests.	'	
FIT-ACM2	Programming Practices 2	KZ	5
'	This is a selective course for preparing talented student for representation in international programming contests.	'	'
FIT-ACM3	Programming Practices 3	KZ	5
ı	This is a selective course for preparing talented student for representation in international programming contests.	1	!
FIT-ACM4	Programming Practices 4	KZ	5
'	This is a selective course for preparing talented student for representation in international programming contests.	'	'
FIT-ACM5	Programming Practices 5	KZ	5
1	This is a selective course for preparing talented student for representation in international programming contests.		!
FIT-ACM6	Programming Practices 6	KZ	5
1	This is a selective course for preparing talented student for representation in international programming contests.	1	ı
FIT-ITI	Modern IT infrastructure	Z,ZK	5
with a very limited and tir	me-invariable range of software or hardware, this subject tries to explain the issue as a whole and in the context of the time. A mo	odern data or comp	uting cente
•	a complex whole, the individual parts of which must be reconciled from different aspects of the view using current technologies.	•	•

thus be capable of continuous and economically optimal operation.

FIT-SEP World Economy and Business Z,ZK This course is presented in Czech. The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom. corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite. FITE-EHD Introduction to European Economic History The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion. NI-ADM **Data Mining Algorithms** Z,ZK The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods). NI-ADP Architecture and Design patterns Z,ZK 5 The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems. NI-AFP ΚZ Applied Functional Programming This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice. Algorithms of Information Security NI-AIB Z,ZK 5 Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems. NI-AM1 Middleware Architectures 1 Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications NI-AM2 Middleware Architectures 2 5 Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security NI-AML Advanced machine learning 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. Completing a professional event The subject is participation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafting a report, etc. Such an event must be approved in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT through a website, infomail, etc. NI-APH Architecture of computer games Z,ZK Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also from design and philosophical perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base components that form an integral part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important part of the course is an implementation of a simple game, with a strong focus on nontrivial game mechanics. NI-APR Selected Methods for Program Analysis Z,ZK This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs. NI-APT Advanced Program Testing Z,ZK 5 Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution. NI-ARI Computer arithmetic 4 Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units. NI-ATH AlgorithmicTheories of Games 4 Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation. NI-BKO **Error Control Codes** Z,ZK 5 The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels. NI-BML Bayesian Methods for Machine Learning K7 The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.

NI-BPS Wireless Computer Networks Z,ZK Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools NI-BUI **Business Informatics** Z,ZK The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management, and lifecycle management of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO). NI-BVS **Embedded Security** Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems. NI-CCC Creative Coding and Computational Art Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE.) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL). NI-CPX Complexity Theory Z,ZK 5 Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems. Capture The Flag The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security. NI-DDM Distributed Data Mining K7 Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands on experience with large scale data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations and will be capable to propose approaches to parallelize other algorithms. The course is prezented in czech language. NI-DDW Web Data Mining Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems. 7 NI-DID Digital drawing The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color theory, which they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course is fit for anyone who wants to practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge. NI-DIP Diploma Thesis 30 NI-DNP Advanced .NET Z,ZK Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WPF, UWP), Blazor and also will get notions of Azure DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing technologies ASP.NET Core, Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT. Game Design The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game design. It is intended for people interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics design, storytelling, and game development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semestral projects. NI-DSS **Decision Support Systems** Z,ZK 5 The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-oriented and knowledge-oriented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will also learn about the principles of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms. Distributed Systems and Computing 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. Design Sprint Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation). Introduction to Discrete and Computational Geometry The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component. NI-DZO Digital Image Processing Z.ZK 4 This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting. NI-FDW Enterprise Data Warehouse Systems Z,ZK The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowledge not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the area of reporting and data visualization

NI-EHW	Embedded Hardware	Z,ZK	5
_	basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the		
systems, that profi	t from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,	including standardi	zed means
===	of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NI-EPC	Effective C++ programming	Z,ZK	5
	v to use the modern features of contemporary versions of the C++ programming language for software development. The course focu- ficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor t		g effectivity
NI-ESC	Experimental Project Course	KZ	8
	permental infoject course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, n	1	_
	ology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design pro	_	
experts, and learn	n to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills	in user-centered d	esign and
	user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."		
NI-ESW	Embedded Software	Z,ZK	5
	e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the bar		
in C language and	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, u	p to sophisticated to	echniques
NI-EVY	combined with artificial intelligence.	Z,ZK	
	Efficient Text Pattern Matching edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces		5 complexity
otadento get know	They will be able to use the knowledge in design of applications that utilize pattern matching.	3 time and memory	complexity.
NI-FME	Formal Methods and Specifications	Z,ZK	5
	to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some so		
	basic properties of software.		·
NI-FMT	Finite model theory	Z,ZK	4
	rse is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of		
systems. Since its	inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as det	scriptive complexity	theory, the
NII O AIG	Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.	7.71	
NI-GAK	Graph theory and combinatorics	Z,ZK	5
_	ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top	•	- 1
_	theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory v		
<i>y</i>	of combinatorics on words, formal languages and bioinformatics.	••	
NI-GEN	Code Generators	Z,ZK	5
	iues of translating programs written in high-level programming languages are essential for understanding the field of systems prograr		
understanding the	algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems progr		will become
	familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming lan		
NI-GLR	Games and reinforcement learning crement learning crement learning crement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelliger	Z,ZK	4
The field of feililoi	give you both theoretical and practical background so you can participate in related research activities. Presented in Englis		iteriaea to
NI-GNN	Graph Neural Networks	Z,ZK	4
	oduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural r	. , .	
representations of	of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last p		so covers
	graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and pro-	blems.	
NI-GOL	Programming of distributed systems in GO	KZ	5
NI-GPU	GPU Architectures and Programming	Z,ZK	5
	knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CU		
wnich is already a v	widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.	iputational structure	es, students
NI-GRI	Grid Computing	Z,ZK	5
IVI-OIXI	Grid computing and gain knowledge about the world-wide network and computing infrastructure.	2,21	3
NI-HCM	Mind Hacking	ZK	5
	is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, infi		
the domain of cog	nitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive secur	ity is growing in imp	ortance in
the context of infor	mation warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet	environment have r	eal societal
	impacts such as disruption of social cohesion, threats to democracy or war.		
NI-HMI2	History of Mathematics and Informatics	ZK	3
i nis course is pr	esented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithm functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its develop		recursive
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
	edicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attact		
	ide channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and	-	
attacks. T	They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel	information leakage	е.
NI-HWB	Hardware Security	Z,ZK	5
	es the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguard	_	-
-	neans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stude	=	dge about
	yptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions		A
NI-IAM	Internet and Multimedia se is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acq	Z,ZK	4 ls (input)
	signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical u	_	
•	nissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the eff		
the quality and late	ency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the	e scene up to the p	resentation
	for audience.		

NI-IBE	Information Security	ZK	2
	ormation and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internation		· 1
	d methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g.		
NI-IKM	Internet and Classification Methods students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering	Z,ZK	4
	ion systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving		
	d of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle w		
exercises.	During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consul	t their semester tas	sks.
NI-IOS	Advanced techniques in iOS applications	KZ	4
Students will learn	the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the b	asics from the begi	inners class
	BI-IOS.		
NI-IOT	Internet of Things	Z,ZK	4
The subject is i	ocused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is fa development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (G		avallable
NI-IVS	Intelligent embedded systems	KZ	4
	led systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The		-
_	mbedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programm		
development. Lectu	ares 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 tech		
NI-KOD	Data Compression	Z,ZK	5
	duced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data		
used in practice. Tr	ne overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, studio lossy data compression methods used in image, audio, and video compression.	ents learn the lund	amentais of
NI-KOP	Combinatorial Optimization	Z,ZK	6
_	gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not onl		_
`	also to apply and evaluate heuristics for practical problems.		
NI-KRY	Advanced Cryptology	Z,ZK	5
Students will learn	n the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know t	ne mathematical pi	rinciples of
random number	generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they c	an apply to the inte	egration of
NII IZTU	their own systems or to the creation of their own software solutions.	7.71/	4
NI-KTH	Combinatorial Theories of Games theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory stu-	Z,ZK	of agents
-	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game t		- 1
	s of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-playe	· · · · · · · · · · · · · · · · · · ·	- 1
games, was by Co	onway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is	to evaluate games	s such that
-	patible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The this		
	established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force tra	•	
	k introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course req		
-	analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theor		- 1
Í	looking for research topics.		
NI-KYB	Cybernality	ZK	5
	uainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the		
	f systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activ		The course
	will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CI		_
NI-LOM Students learn the	Linear Optimization and Methods applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear a	Z,ZK	5
	th optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization optimization of optimization optimizati		, ,
	scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travell	•	
issues from econo	mics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. The	y get orientation in	algorithms
	in linear programming.		_
NI-LSM2	Statistical Modelling Lab	KZ	5
The topic of LSIVIZ	is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the preser We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli)		eo tracking.
NI-MCC	Multicore CPU Computing	Z,ZK	5
	requainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on mu		
-	red memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowled	· ·	
optimization techni	ques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and		throughput.
	On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		
NI-MEP	Modelling of Enterprise Processes	Z,ZK	5
i ne subject is	focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approa implementation of processes, organisation structures and information support in big enterprises and institutions.	cn for (re)engineer	ing and
NI-MKY	Mathematics for Cryptology	Z,ZK	5
	deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In		
-	f solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discre		
	factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on	lattices.	
NI-MLP	Machine Learning in Practice	Z,ZK	5
	earning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ide	-	
-	students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically sing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and	-	
Gata proces	and team team to december the mines process from experience to evaluation of the model performance in the form of a clear and	aaorotaridabie le	P-011.

NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
	ogramming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where in The plex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills	•	
	in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development no		
	ing object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work of		
technologies in ter	ms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvem	ent in the Pharo C	Consortium.
NI-MPI	Mathematics for Informatics	Z,ZK	7
-	orises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analys ation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last top		
_	r stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear pre		
NI-MPJ	Modelling of Programming Languages	Z,ZK	5
	formation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve the	ne semantics of the	e language.
	es the semantics of programming languages. The students will learn the language models with emphasis on functional languages, students will be semantics of programming languages. The students will learn the language models with emphasis on functional languages, students will be semantics of programming languages.	•	
	mbda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with semantic		
NI-MPL	Managerial Psychology	ZK	2
NI-MPR	Master Project g of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial ta	Z	7
	ir. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of		
	he information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/s		
completed and sigr	ned form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic	that the student ha	as 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 immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should aim at fine-tuning the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the supervisor as supervisor as the supervisor as su	he FTT will be com	nplete and
NII MOI	approvable at the end of the semester.	7 714	4
NI-MSI Mathematical se	Mathematical Structures in Computer Science emantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scott	Z,ZK	4 calculus
Matrierriatical se	Introduction to category theory.	. model of lambda (calculus.
NI-MTI	Modern Internet Technologies	Z,ZK	5
	ubject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration - A	,	
	arry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video		
-	. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of		
	there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and ow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela		
-	eration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in		10001). 4.
NI-MVI	Computational Intelligence Methods	Z,ZK	5
Students will under	· · · · · · · · · · · · · · · · · · ·	, ,	v will loom
Otadents will and	erstand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to m	any problems. They	y wili learn
	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations,	etc.	y will learn
NI-MZI	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, Mathematics for data science	etc. Z,ZK	4
NI-MZI In this course, stud	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, Mathematics for data science ents are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in da	etc. Z,ZK ata science. The stu	4 udied topics
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NI-MZI In this course, stud include mainly: li NI-NLM	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, Mathematics for data science ents are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in danear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality prince)	etc. Z,ZK uta science. The stuiple, gradient meth	4 udied topics nods) and
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NI-MZI In this course, stud include mainly: li NI-NLM In this course, stud	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, Mathematics for data science ents are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in data near algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principles as selected notions from probability theory and statistics. Neural Language Models ents will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific lit Neural Networks, Machine Learning and Randomness	etc. Z,ZK ata science. The studiel, gradient method Z a goal of the course derature. Z,ZK	4 udied topics nods) and 5 e is to teach
NI-MZI In this course, stud include mainly: li NI-NLM In this course, stud NI-NMS Stochastic method	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, Mathematics for data science ents are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in data near algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principles and statistics. Neural Language Models ents will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific litter and training and Randomness and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks.	etc. Z,ZK ata science. The studiel, gradient method Z e goal of the course derature. Z,ZK per of other machine	4 udied topics nods) and 5 e is to teach 4 ne learning
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NI-OSY Operating Systems and Systems Programming Z,ZK 5 The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel data structures. Key topics are: process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The course also addresses kernel development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. Specifics of kernel architecture in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, students will work on projects focused on development of LINUX kernel modules NI-PAM Efficient Preprocessing and Parameterized Algorithms Z,ZK There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes. NI-PAS Advanced Aspects of Business 4 The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run their own business or business management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspects NI-PDB Advanced Database Systems Z,ZK 5 Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines. NI-PDD **Data Preprocessing** Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteristics from images or from web pages. NI-PDP Parallel and Distributed Programming Z,ZK 21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Parallel computing systems are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course includes a semester project of practical programming in OpenMP and MPI for solving a particular nontrivial problem. NI-PG1 Computer Grafics 1 7K 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-PIS **Enterprise Information Systems** The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data (BigData) and their use in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunications sectors will be explained on real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the business strategy of the company. Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation of information systems in the company / organization. NI-PIV Computer Vision The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing. Students will get acquainted with the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical knowledge as well as on practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, ViT), motion detection, visual expressiveness (saliency). NI-PLS1 Programming Language Seminar The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages. NI-PLS2 Programming Language Seminar The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages NI-PLS3 Programming Language Seminar 2 The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages NI-PLS4 Programming Language Seminar 2 The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages NI-PON Selected Topics in Optimization and Numerical mathematics Z,ZK The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-PSD Public Services Design The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients.

NI-PSL Programming in Scala Z,ZK The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g.pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra, Scalaz, etc. NI-PVR **Advanced Virtual Reality** ΚZ The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D models in Blender, and among other things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also deal with creating applications in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the knowledge gained in this subject in virtual reality, or directly create a complex game for VR. NI-PVS Advanced embedded systems The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced topics like security support, working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical experiences with embedded systems. NI-PYT Advanced Python ΚZ The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python (BI-PYT) left of. The course is very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework. The course is lead by external teachers from Red Hat. NI-REV Reverse Engineering Z,ZK 5 Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens before and after the main function is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedicated to reverse engineering of applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be dedicated to debuggers; how debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer malware scene. The focus of the course is on the seminars, where students will solve practically oriented tasks from the real world. NI-ROZ Z.ZK Pattern Recognition The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects. NI-RUB Programming in Ruby This course is presented in Czech. NI-RUN Z,ZK Runtime Systems 5 This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience in design and implementation of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compilation Memory management Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementations of real-world VMs, including Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs System Security and Forensics Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication concepts). Furthermore, students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic analysis techniques and the importance of operating system/operating system artifacts or file system for attack analysis and detection). Computer Engineering Seminar Master I 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 K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCE2 Computer Engineering Seminar Master II Ζ 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 K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCR Statistical Analysis of Time Series Z,ZK The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, employment) and industrial problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenient process model, estimate its parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main principles based on practical real-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer of students' knowledge from the academic to the real world. NI-SEP World Economy and Business Z.ZK 4 This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite. NI-SIB **Network Security** NI-SIM Digital Circuit Simulation and Verification 5 The aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers recent verification methods, too. NI-SWE Semantic Web and Knowledge Graphs The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance. Parsing and Compilers NI-SYP Z,ZK The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.

NI-SZ1 Knowledge Engineering Seminar Master I Ζ On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet). NI-SZ2 Z Knowledge Engineering Seminar Master II 4 On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet). NI-TES Systems Theory Z,ZK Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems. NI-TKA **Category Theory** Z.ZK NI-TNN Theory of Neural Networks Z,ZK 5 In this course, we study neural networks from the point of view of the theory of function approximation and from the point of view of probability theory. At first, we recall basic concepts pertaining to artificial neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission, network topology, somatic and synaptic mappings, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transformation into a canonical topology, and in connection with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with training, we pay attention to the problem of overtraining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most important optimization methods employed for neural network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the topic approximation approach to neural networks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Kolmogorov theorem, Vituškin theorem). Afterwards, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings computed by neural networks. being dense in important Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to a finite measure, spaces of functions with continuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expectation and training based on a random sample, and with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how it is possible to get an estimate of the conditional expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law of large numbers and get acquainted with an analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the central limit theorem, get acquinted with its analogy for neural networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be employed to search for the topology of the network. NI-TS1 Theoretical Seminar Master I Ζ 4 Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-TS2 Theoretical Seminar Master II Ζ Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-TS3 Theoretical Seminar Master III 7 4 Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-TS4 Theoretical Seminar Master IV 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. Testing and Reliability Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with built-in-self-test equipment. They will be able to compute, analyze, and control the reliability and availability of the designed circuits. NI-TSW Software Product Development ΚZ The course is presented in Czech. NI-TVR Virtual Reality Technology Z,ZK 3 Students will be introduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD, ...) and the possibilities of controlling virtual avatars (position tracking, hand tracking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of using virtual and augmented reality will be presented. NI-UMI Artificial intelligence Z,ZK 5 The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated. NI-VCC Virtualization and Cloud Computing Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development). Video Games Architecture The course covers a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of view, but also from a design and philosophical point of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and functional architecture typical of game development, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, including ways of implementing some game mechanics, in the form of practical demonstrations.

NI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtain	s general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of fea	ture extraction fror	n multimedia
	objects, indexing, and structure of distributed search engines.		
NI-VOL	Elections	Z,ZK	5
	We will cover the basics of (committee) elections and, in general, opinion aggregation.		
NI-VPR	Research Project	Z	5
	Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.	•	
NI-VSM	Selected statistical Methods	Z,ZK	7
The course leads	the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with m		distribution,
application of en	tropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with ran-	dom processes wi	th focus on
	Markov chains. The high point of the course is the Queuing theory and its application in networks.		
NI-VYC	Computability	Z,ZK	4
	Classical theory of recursive functions and effective computability.	_,	1
NI-ZS10	Master internship abroad for 10 credits	7	10
	once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institu	_	_
	the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex		-
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	on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects		•
a reverger meanan	academic year's dead-line.		
NI-ZS20	Master internship abroad for 20 credits	Z	20
	once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institu	I	-
	the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex		-
	MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 week		
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synthesis and optimization algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial problems emerging in EDA.

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