Studijní plán

Název plánu: Master specialization Software Engineering, in English, 2021

Sou ást VUT (fakulta/ústav/další): Fakulta informa ních technologií

Katedra:

Obor studia, garantovaný katedrou: Úvodní stránka

Garant oboru studia.:

Program studia: Informatics

Typ studia: Navazující magisterské prezen ní

P edepsané kredity: 102

Kredity z volitelných p edm t: 18 Kredity v rámci plánu celkem: 120

Poznámka k plánu: The study plan is intended for those students who have been accepted to study since the academic year 2021/2022. Guarantor: Ing. Michal Valenta, Ph.D., email: michal.valenta@fit.cvut.cz

Název bloku: Povinné p edm ty programu

Minimální po et kredit bloku: 63

Role bloku: PP

Kód skupiny: NIE-PP.21

Název skupiny: Compulsory Courses of Master Study Program, Version 2021

Podmínka kredity skupiny: V této skupin musíte získat 63 kredit

Podmínka p edm ty skupiny: V této skupin musíte absolvovat 6 p edm t

Kredity skupiny: 63 Poznámka ke skupině:

Kód	Název p edm tu / Název skupiny p edm t (u skupiny p edm t seznam kód jejích len) Vyu ující, auto i a garanti (gar.)	Zakon ení	Kredity	Rozsah	Semestr	Role
NIE-KOP	Combinatorial Optimization Petr Fišer, Jan Schmidt Petr Fišer Petr Fišer (Gar.)	Z,ZK	6	3P+1C	Z	PP
NIE-DIP	Diploma Project Zden k Muziká	Z	30	270ZP	L,Z	PP
NIE-MPR	Master Project Zden k Muziká Zden k Muziká (Gar.)	Z	7		Z,L	PP
NIE-MPI	Mathematics for Informatics Francesco Dolce Št pán Starosta Št pán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NIE-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík (Gar.)	Z,ZK	6	2P+2C	L	PP
NIE-VSM	Selected statistical Methods Petr Novák Pavel Hrabák Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

Charakteristiky p edmet této skupiny studijního plánu: Kód=NIE-PP.21 Název=Compulsory Courses of Master Study Program, Version 2021

NIE-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain	nowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not	only to select and	I implement but
also to apply and evalu	ate heuristics for practical problems.		
NIE-DIP	Diploma Project	Z	30
NIE-MPR	Master Project	Z	7

1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. 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.

NIE-MPI Mathematics for Informatics Z,ZK 7

The course focuses on selected topics from general algebra with emphasis 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 the demonstration of applications in computer science. The course focuses on clear presentation and argumentation.

NIE-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.

NIE-VSM

Selected statistical Methods

Z,ZK

7

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

Název bloku: Povinné p edm ty specializace

Minimální po et kredit bloku: 35

Role bloku: PS

Kód skupiny: NIE-SI-PS.21

Název skupiny: Compulsory Courses of Master Specialization Software Engineering, v.2021, in Czech

Podmínka kredity skupiny: V této skupin musíte získat 35 kredit

Podmínka p edm ty skupiny: V této skupin musíte absolvovat 7 p edm t

Kredity skupiny: 35 Poznámka ke skupině:

i oznanika ke	o chapme.					
Kód	Název p edm tu / Název skupiny p edm t (u skupiny p edm t seznam kód jejích len) Vyu ující, auto i a garanti (gar.)	Zakon ení	Kredity	Rozsah	Semestr	Role
NIE-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-PIS	Advanced Information Systems Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-ADP	Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-AM1	Middleware Architectures 1 Tomáš Vitvar, Milan Doj inovski, Jaroslav Kucha Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-NSS	Normalized Software Systems Jan Verelst, Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	PS
NIE-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	PS

Charakteristiky p edmet této skupiny studijního plánu: Kód=NIE-SI-PS.21 Název=Compulsory Courses of Master Specialization Software Engineering, v.2021, in Czech

NIE-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

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. This course is equivalent to the course MIE-PDB.

NIE-PIS Advanced Information Systems

7.7K

5

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

NIE-ADP Architecture and Design patterns

Z.ZK

5

The aim of this course is to provide students with practical knowledge of the basic principles of object-oriented design and its analysis, together with an understanding of the challenges, questions and compromises associated with advanced software design. In the first part of the course, students will review and deepen their knowledge of object-oriented programming and learn the most commonly used design patterns, which represent the best practices for solving typical software design problems. In the second part of the course, students will be introduced to the principles of design and analysis of software architecture including classical architectural designs, component systems and some advanced software architectures of large distributed systems. If you need to contact the teacher of NIE-ADP, please write an e-mail to Ing. Jiri Borsky borskjir@fit.cvut.cz

NIE-FME Formal Methods and Specifications

Z,ZK

5

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

NIE-AM1 Middleware Architectures 1

Z,ZK

5

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

NIE-NSS Normalized Software Systems

ZK

5

Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures.

NIE-NUR User Interface Design

Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs. This course replaces MIE-MDW.

Název bloku: Povinn volitelné p edm ty

Minimální po et kredit bloku: 4

Role bloku: PV

Kód skupiny: NIE-PV-SI.21

Název skupiny: Compulsory Elective Master Courser for Specialization Software Engineering, version 2021

Podmínka kredity skupiny: V této skupin musíte získat alespo 4 kredity (maximáln 14)

Podmínka p edm ty skupiny: V této skupin musíte absolvovat alespo 1 p edm t (maximáln 3)

Kredity skupiny: 4 Poznámka ke skupině:

Kód	Název p edm tu / Název skupiny p edm t (u skupiny p edm t seznam kód jejích len) Vyu ující, auto i a garanti (gar.)	Zakon ení	Kredity	Rozsah	Semestr	Role
NIE-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl Petra Pavlí ková Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	PV
NIE-MEP	Modelling of Enterprise Processes Robert Pergl Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	PV
NIE-TSW	Software Product Development Petra Payli ková Petra Payli ková (Gar)	KZ	4	1P+2C	Z	PV

Charakteristiky p edmet této skupiny studijního plánu: Kód=NIE-PV-SI.21 Název=Compulsory Elective Master Courser for Specialization Software Engineering, version 2021

NIE-DSS Decision Support Systems Z,ZK

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.

NIE-MEP Modelling of Enterprise Processes Z,ZK

The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions.

Software Product Development

ΚZ

The course aims to acquaint students with the tools and procedures of project management in the ICT environment. By completing the course, students will master the various methods and techniques of project management and apply them in practice. Students will get acquainted with the issue of creating an IT product, ie. preparation of business model, creation of financial model and creation of project schedule including basic design of architecture and appearance of the given IT product. At the same time, they will try to present the prepared parts of the project to a jury composed of experts from practice. // This course is a continuation of the bachelor's course Project Management.

Název bloku: Volitelné p edm ty Minimální po et kredit bloku: 0

Role bloku: V

Kód skupiny: NIE-SI-VS.21

Název skupiny: Elective Vocational Courses for Master Specialisation Software Engineering

Podmínka kredity skupiny: Podmínka p edm ty skupiny:

Kredity skupiny: 0

Poznámka ke skupině:

Compulsory courses of all specializations with the exception of this specialization.

Kód	Název p edm tu / Název skupiny p edm t (u skupiny p edm t seznam kód jejích len) Vyu ující, auto i a garanti (gar.)	Zakon ení	Kredity	Rozsah	Semestr	Role
NIE-KRY	Advanced Cryptology Ji í Bu ek, Róbert Lórencz Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	V
NIE-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MVI	Computational Intelligence Methods Miroslav epek, Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-ADM	Data Mining Algorithms Rodrigo Augusto Da Silva Alves Rodrigo Augusto Da Silva Alves Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-SIM	Digital Circuit Simulation and Verification Martin Kohlik Martin Kohlik Martin Kohlik (Gar.)	Z,ZK	5	2P+1C	L	V

NIE-DSV	Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BVS	Embedded Security Ji í Bu ek, Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-HWB	Hardware Security Ji i Bu ek Ji i Bu ek (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz, Olha Jure ková Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	V
NIE-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-SIB	Network Security Tomáš Zahradnický, Ji í Dostál, Simona Forn sek, Gramoz Cubreli Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	V
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	V
NIE-SBF	System Security and Forensics Tomáš Zahradnícký, Ji í Bu ek, Simona Forn sek, Marián Svetlík Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-TES	Systems Theory Tomáš Kolárik, Stefan Ratschan, Ji í Vysko il Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-TSP	Testing and Reliability Petr Fišer Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NIE-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
Charakteristiky p ed Software Engineerin	met této skupiny studijního plánu: Kód=NIE-SI-VS.21 Název=Ele g	ective Vocatio	onal Cou	rses for M	aster Spe	cialisatior
NIE-KRY A	dvanced Cryptology			Z	,ZK	5
Students will learn the esse	entials of cryptanalysis and the mathematical principles of constructing symmetric and a	symmetric ciphe	rs. They will	know the ma	athematical p	rinciples of
random number generators	s. They will have an overview of cryptanalysis methods, elliptic curve cryptography and q	uantum cryptogr	aphy, which	they can ap	ply to the inte	gration of
their own systems or to the	creation of their own software solutions.					
	lgorithms of Information Security ritmy bezpe ného generování klí a kryptografickým zpracováním chybových (nejen bio	metrických) dat. l	Dále se stu	I	,ZK í s matematio	5 kými principy
	, J.	, . ,				

random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptograp	hy, which they can apply to the i	ntegration of
their own systems or to the creation of their own software solutions.		
NIE-AIB Algorithms of Information Security	Z,ZK	5
Studenti se seznámí s algoritmy bezpe ného generování klí a kryptografickým zpracováním chybových (nejen biometrických) dat. Dá	le se studenti seznámí s matem	atickými principy
kryptografických protokol (identifika ních, autentiza ních a podpisových schémat). Získají znalosti o metodách detekce malware a podpisových schémat).	oužití strojového u ení v detek n	ích algoritmech.
Taktéž se seznámí s metodami vytvá ení steganografických záznam , s metodami pro jejich vyhledávání a s útoky na n .		
NIE-MVI Computational Intelligence Methods	Z,ZK	5
Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intel	ligence, are parallel in nature an	d are applicable
to solving a wide range of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuro	evolution. Students will learn how	v these methods
work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation, etc.		
NIE-KOD Data Compression	Z,ZK	5
Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an	overview of data compression m	ethods being
used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods	. In addition, students learn the	fundamentals of
lossy data compression methods used in image, audio, and video compression.		
NIE-ADM Data Mining Algorithms	Z,ZK	5
The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course,	and the students should know 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., received algorithms).	ommendation systems) and mod	dels (e.g., kernel
methods).		
NIE-SIM Digital Circuit Simulation and Verification	Z,ZK	5
Aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Tran		

properties of proper tools. The course covers today recent verification methods, too.

NIE-DSV	Distributed Systems and Computing	Z,ZK	5
	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of compu sic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms th		
	safety in case of failures.	iat support riigir a	valiability of both
NIE-EPC	Effective C++ programming	Z,ZK	5
	is the modern features of contemporary versions of the C++ programming language for software development. The course f		nming effectivity
· · · · · · · · · · · · · · · · · · ·	m of writing maintainable and portable source code and creating correct programs with low memory and processor time requ		
NIE-EVY	Efficient Text Pattern Matching e of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both ac	Z,ZK	5 mory complexity
	the knowledge in design of applications that utilize pattern matching.		nory complexity.
NIE-EHW	Embedded Hardware	Z,ZK	5
_	c laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is t		
	n their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discuss	ed, including stan	dardized means
NIE-BVS	on, parallelism extraction and utilization in special structures and system architectures. Embedded Security	Z,ZK	5
	pulledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cr		
_	ded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resou		
of computer systems.			
NIE-ESW	Embedded Software	Z,ZK	5
	rrse acquainted students with the specifics of software development for embedded systems. The course covers the areas from the potimizations, through typical areas as the reliable software development, embedded operating systems, signal processing	•	
combined with artificial		up to sopriisticat	ed techniques
NIE-BKO	Error Control Codes	Z,ZK	5
	e basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary materials		and principles of
	codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to impl		ctions and
	types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channe		
NIE-GPU	GPU Architectures and Programming ledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the	Z,ZK	5 na environment
_	spread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical		-
	ion programming techniques and methods of programming multiprocessor GPU systems.	,	
NIE-GAK	Graph theory and combinatorics	Z,ZK	5
_	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith	-	-
_	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 theo		
	y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo rds, formal languages and bioinformatics.	ry will be also app	illed iii tiile iields
NIE-HWB	Hardware Security	Z,ZK	5
	e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu	_	-
_	They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stu	=	wledge about
NIE-MKY	erators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the cards and devices for Cryptology	Z,ZK	5
	rnalosti o algebraických postupech ešících nejd ležit jší matematické problémy, na kterých je založena bezpe nost šifer. Ze		_
-	h rovníc nad kone ným t lesem, problém faktorizace velkých ísel a problém diskrétního logaritmu. Problém faktorizace bud		
	vnež seznámí s moderními šifrovacími systémy založenými na poítání na mížce.		
NIE-MTI	Modern Internet Technologies	Z,ZK	5
	ed networking technologies and protocols for both local area networks and wide area networks. They get acquainted with rou i internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.	ting techniques ar	id transfer
NIE-MCC	Multicore CPU Computing	Z,ZK	5
	inted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or	· '	
	mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of a	=	
-	uce the decrease in computing power due to the widening performance gap between the computational requirements of multi	-core CPUs and n	nemory interface
	non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.	7.71/	
NIE-SIB	Network Security heoretical knowledge and experience in the area of current security threats in computer networks, specifically a	Z,ZK	5 d defense The
_	ricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network to		
	al examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general		
	dent handling and incident response).		
NIE-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 me element method and the finite difference method used for solving ordinary and partial differential equations in engineering. T		
	ns that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme		
as well as in parallel.		3	
NIE-SYP	Parsing and Compilers	Z,ZK	5
-	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 ii NIE-REV	ntroduced to special applications of parsers, such as incremental and parallel parsing.	7 71/	5
	Reverse Engineering Imperials of reverse engineering of computer software (methods of executing and initializing programs, organization of execu	Z,ZK utable files. work v	_
	tion will be paid to C ++. Students will also become familiar with the principles of debugging tools, disassemblers and obfusca		
	pression and decompression and executable file reconstruction.		
NIE-SBF	System Security and Forensics	Z,ZK	5
	ced to various aspects of system security (principles of endpoint security, principles of security policies, security models, auth	-	·
	ic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis m artifacts for attack analysis and detection).	teoriniques, and	не широпапсе

NIE-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.

NIE-TSP Testing and Reliability

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.

NIE-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).

Kód skupiny: NIE-V.21

Název skupiny: Purely elective master's courses

Podmínka kredity skupiny: Podmínka p edm ty skupiny:

Kredity skupiny: 0 Poznámka ke skupině:

Kód	Název p edm tu / Název skupiny p edm t (u skupiny p edm t seznam kód jejích len) Vyu ující, auto i a garanti (gar.)	Zakon ení	Kredity	Rozsah	Semestr	Role
NIE-BLO	Blockchain Josef Gattermayer, Róbert Lórencz, Jakub R ži ka, Marek Bielik Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	V
NIE-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	3P+1C	Z	V
NIE-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-MVI	Computational Intelligence Methods Miroslav epek, Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NIE-SCE1	Computer Engineering Seminar Master I Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	Z	V
NIE-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná Denisa Nová ková Denisa Nová ková (Gar.)	Z	2	4C	Z,L	٧
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler Pavel Tvrdík André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-HMI	History of Mathematics and Informatics Alena Šolcová Alena Šolcová (Gar.)	Z,ZK	3	2P+1C	Z	V
NIE-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	٧
MIE-MZI	Mathematics for data science Št pán Starosta	Z,ZK	4	2P+1C	L	V
NIE-AM2	Middleware Architectures 2 Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-PAM	Parameterized Algorithms Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ROZ	Pattern Recognition Michal Haindl Michal Haindl (Gar.)	Z,ZK	5	2P+1C	Z	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-AML	Pokro ilé techniky strojového u ení Zden k Buk, Miroslav epek, Petr Šimánek, Rodrigo Augusto Da Silva Alves, Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)	Z,ZK	5	2P + 1C	L	٧

NIE-PDL	Practical Deep Learning	KZ	5	2P+1C	Z	V
	Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)			2F+1C		V
NIE-VPR	Research Project Št pán Starosta Št pán Starosta Št pán Starosta (Gar.)	Z	5		Z,L	V
NIE-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
MI-SCE1	Seminá po íta ového inženýrství l Hana Kubátová	Z	4	2C	L,Z	V
NIE-HSC	Side-Channel Analysis in Hardware Vojt ch Miškovský, Petr Socha Vojt ch Miškovský Vojt ch Miškovský (Gar.)	Z,ZK	4	2P+2C	Z	V
NIE-DDW	Web Data Mining Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-BPS	Wireless Computer Networks Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
MIE-SEP	World Economy and Business Tomáš Evan Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z	V
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	omputational Intelligence Methods	Manage and the second	III		',ZK	5
	ne basic methods and techniques of computational intelligence, which are based on trad		•			
	roblems. The subject is also devoted to modern neural networks and the ways in which th	-	roevolution	. Students wil	II learn how	tnese metho
ork and how to apply the	n to problems related to data extraction, management, intelligence in games and optimis	sation, etc.				
NIE-EVY E	fficient Text Pattern Matching			Z	,ZK	5
	efficient algorithms for text pattern matching. They learn to use so called succinct data stru	ctures that are e	fficient in bo	ı		ory complex
	s knowledge in design of applications that utilize pattern matching.					. 1
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•	knowledge of fundamentals of automata theory, formal language and formal translation the	eories. Students	gain knowle	eage of variou	is variants a	ind applicatio
	duced to special applications of parsers, such as incremental and parallel parsing.					
IIE-BLO E	lockchain			Z	,ZK	5
tudents will understand t	e foundations of blockchain technology, smart contract programming, and gain an overview	ew of most notab	le blockcha	in platforms.	They will be	able to design
I I	omplexity Theory ne fundamental classes of problems in the complexity theory and different models of algo	oritms and about	implication		Z,ZK ry concernir	5 ng practical
n)tractability of difficult pr				1 7	77/	
	omputability re functions and effective computability.			4	ː,ZK	4
1	omputer arithmetic data representations used in digital devices and will be able to design arithmetic operati	ons implementat	ion units	Z	Z,ZK	4
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The course focuses on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science The topics are selected

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

In this course, the students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in data science. The studied topics include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle, gradient methods) and

Z,ZK

Z,ZK

5

for finding some relations between computer science and mathematical methods. Some examples of applications of mathematics to computer sciences will be showed.

Introduction to Discrete and Computational Geometry

of this discipline, and to be able to solve simple algorithmic problems with a geometric component.

Mathematics for data science

selected notions from probability theory and statistics.

NIE-DVG

MIE-MZI

NIF-AM2 Middleware Architectures 2 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. NIF-PAM 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. NIE-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 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. NIE-PML Personalized Machine Learning 7.7K 5 Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities. NI-AMI Pokro ilé techniky strojového u ení P edm t seznamuje studenty s vybranými pokro ilými tématy strojového u ení a um lé inteligence a jejich aplikace na reálné problémy. Témata p edstavují techniky v oblasti doporu ovacích systém , zpracování obrazu, ízení i propojení fyzikálních zákon s oblastí strojového u ení. Cílem cvi ení je podrobn seznámit studenty s probíranými metodami. NIE-PDL Practical Deep Learning K7 This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing. NIE-VPR Research Project Ζ 5 Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en. Semantic Web and Knowledge Graphs Z.ZK 5 NIF-SWF 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. MI-SCE1 Seminá po íta ového inženýrství I Seminá po íta ového inženýrství je výb rový p edm t pro studenty, kte í se cht jí zabývat hloub ji tématy íslicového návrhu, spolehlivosti a odolnosti proti poruchám a útok m. Ke student m se v rámci p edm tu p istupuje individuáln a každý student i skupinka student eší n jaké zajímavé aktuální téma s vybraným školitelem. Sou ástí p edm tu je práce s v deckými lánky a jinou odbornou literaturou a/nebo práce v laborato ích K N. Kapacita p edm tu je omezena možnostmi u itel seminá e. Probíraná témata jsou pro každý semestr **NIE-HSC** Side-Channel Analysis in Hardware 7.7K This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get familiar with various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with higher-order attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage. NIF-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. **NIE-BPS** Wireless Computer Networks 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. World Economy and Business 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.

Seznam p edm t tohoto pr chodu:

Kód	Název p edm tu	Zakon ení	Kredity
MI-SCE1	Seminá po íta ového inženýrství I	Z	4
Seminá po íta ov	ého inženýrství je výb rový p edm t pro studenty, kte í se cht jí zabývat hloub ji tématy íslicového návrhu, spolehlivosti a odolnosti	proti poruchám a	útok m. Ke
	nci p edm tu p istupuje individuáln a každý student i skupinka student eší n jaké zajímavé aktuální téma s vybraným školitelem.	•	
v deckými lánky a	. jinou odbornou literaturou a/nebo práce v laborato ích K N. Kapacita p edm tu je omezena možnostmi u itel seminá e. Probíraná t	émata jsou pro ka	ždý semestr
	nová.		
MIE-MZI	Mathematics for data science	Z,ZK	4
In this course, the s	students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in da	ata science. The st	udied topics
include mainly: li	near algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ	iple, gradient meth	nods) and

selected notions from probability theory and statistics.

MIE-SEP World Econo	my and Business	Z,ZK	4
The course introduces students of technical university to the international business	s. It does that predominantly by comparing individual countries and k	ey regions of world	economy.
Students get to know about different religions and cultures, necessary for doing		•	
development, which are needed for the right investment decision. Seminars help to		ridual readings. It is	advised to
	this course BIE-SEP as a prerequisite.		
	iky strojového u ení	Z,ZK	5
P edm t seznamuje studenty s vybranými pokro ilými tématy strojového u ení			
doporu ovacích systém , zpracování obrazu, ízení i propojení fyzikálních zákon		enty's probitatiymi	
NI-DID Digita P edm t má za cíl p iblížit student m základní principy digitální kresby a grafické t	al drawing tvorby Studenti zíckejí pov domí o základech kompozice, poropoktiv		2 i náalada
budou aplikovat ve svých samostatných pracích. Studenti také získají zkušenosti s		-	
jelikož práv to je nedílnou sou ástí výuky. P edm t bude organizovaný formou tem			
	gn Sprint	7	2
Studenti budou pracovat metodou design sprint, vyvinutou p vodn spole ností G			
nebo služby. B hem kurzu se seznámí s metodou Design Sprint z pohledu ú astn	- · · · · · · · · · · · · · · · · · · ·		
Díky za azení p ed za átek semestru mají studenti možnost vyzk	oušet si metodu, která vyžaduje kontinuáln jší asovou alokaci než b	žná výuka.	
NI-GLR Games and rei	nforcement learning	Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in de-	ep learning, recurrent neural networks and general artificial intelligen	ice. This course is i	ntended to
	you can participate in related research activities. Presented in English	h.	
NI-GRI Grid C	Computing	Z,ZK	5
Grid computing and gain knowledge abo	out the world-wide network and computing infrastructure.		
NIE-ADM Data Mini	ing Algorithms	Z,ZK	5
The course focuses on algorithms used in the fields of machine learning and data r	- · · · · · · · · · · · · · · · · · · ·		- 1
basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and n		tems) and models (e.g., kernel
	methods).		
l	nd Design patterns	Z,ZK	5
The aim of this course is to provide students with practical knowledge of the basic pr		_	_
questions and compromises associated with advanced software design. In the first pand learn the most commonly used design patterns, which represent the best practice.			
introduced to the principles of design and analysis of software architecture including	0 1.		
1	er of NIE-ADP, please write an e-mail to Ing. Jiri Borsky borskjir@fit.c		
	nformation Security	Z,ZK	5
Studenti se seznámí s algoritmy bezpe ného generování klí a kryptografickým zpi		. , .	_
kryptografických protokol (identifika ních, autentiza ních a podpisových schémat)		-	
Taktéž se seznámí s metodami vytvá ení steganogra	fických záznam, s metodami pro jejich vyhledávání a s útoky na n		
	fických záznam , s metodami pro jejich vyhledávání a s útoky na n .e Architectures 1	Z,ZK	5
	Architectures 1	Z,ZK	5
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NIE-AM1 Middleware Students will study new trends, concepts, and technologies in the area of service architecture and aplication servers. The will also study principles and technologies for of applications. This c	e Architectures 1oriented architectures. The will gain an overview of information system in middleware focused on application integrations, asynchronous commourse replaces the course MIE-MDW.	Z,ZK em architecture, we	5 b service n availability
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NIE-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 **NIE-DSV** Z,ZK 5 Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communication channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that support high availability of both data and services, and safety in case of failures. Introduction to Discrete and Computational Geometry NIF-DVG 5 The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component. NIE-EHW **Embedded Hardware** 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. NIE-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 NIE-ESW **Embedded Software** 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. Efficient Text Pattern Matching 5 Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access time and memory complexity. They will be able to use the knowledge in design of applications that utilize pattern matching. Formal Methods and Specifications NIF-FMF Z,ZK 5 Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some software tools that allow to prove basic properties of software. NIF-GAK Graph theory and combinatorics The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The emphasis will be not only on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topics from graph and hypergraph coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be also applied in the fields of combinatorics on words, formal languages and bioinformatics. NIE-GPU **GPU** Architectures and Programming Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUDA programming environment, which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational structures, students will also learn optimization programming techniques and methods of programming multiprocessor GPU systems. History of Mathematics and Informatics 3 The course focuses on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science The topics are selected for finding some relations between computer science and mathematical methods. Some examples of applications of mathematics to computer sciences will be showed. **NIE-HSC** Side-Channel Analysis in Hardware Z,ZK This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get familiar with various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with higher-order attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage NIF-HWB Hardware Security The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer. NIF-KOD Data Compression Z,ZK 5 Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data compression methods being used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, students learn the fundamentals of lossy data compression methods used in image, audio, and video compression. Combinatorial Optimization 6 The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems. NIE-KRY Z,ZK Advanced Cryptology Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions. NIE-MCC Multicore CPU Computing Z.ZK 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 memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the decrease in computing power due to the widening performance 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. NIE-MEP Modelling of Enterprise Processes 5 The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions. **NIE-MKY** Mathematics for Cryptology Z,ZK Studenti získají hlubší znalosti o algebraických postupech ešících nejd ležit jší matematické problémy, na kterých je založena bezpe nost šifer. Zejména se jedná o problém ešení soustavy polynomiálních rovníc nad kone ným t lesem, problém faktorizace velkých (sel a problém diskrétního logaritmu. Problém faktorizace bude speciáln ešen i na eliptických k ivkách. Studenti se rovnež seznámí s moderními šifrovacími systémy založenými na po ítání na m ížce.

NIE-MPI Mathematics for Informatics Z,ZK The course focuses on selected topics from general algebra with emphasis 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 the demonstration of applications in computer science. The course focuses on clear presentation and argumentation. NIE-MPR Master Project 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. Modern Internet Technologies NIF-MTI 7.7K 5 Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquainted with routing techniques and transfer technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security. NIE-MVI Computational Intelligence Methods 5 Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are parallel in nature and are applicable to solving a wide range of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuroevolution. Students will learn how these methods work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation, etc. NIE-NON Nonlinear Continuous Optimization and Numerical Methods Z,ZK 5 Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods to real-world problems. They will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They will learn to solve systems of linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement these algorithms sequentially as well as in parallel. **NIE-NSS** Normalized Software Systems Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures. NIE-NUR User Interface Design Z,ZK Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs. This course replaces MIE-MDW. NIE-PAM 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 Advanced Database Systems 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. This course is equivalent to the course MIE-PDB. Practical Deep Learning This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing. Parallel and Distributed Programming 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. NIE-PIS Advanced Information Systems Students learn the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of service oriented company, enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about agility and adaptivity and using of artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business processes, business rules, processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS. NIE-PML Personalized Machine Learning Z.ZK Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities. **NIE-REV** Reverse Engineering Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of executable files, work with third-party libraries). Special attention will be paid to C++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation methods. Finally, the course will focus on code compression and decompression and executable file reconstruction.

	Pattern Recognition	Z,ZK	5
The aim of the modul	e is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statisti		to pattern
	s will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and th		
NIE-SBF	System Security and Forensics	Z,ZK	5
I	ced to various aspects of system security (principles of endpoint security, principles of security policies, security models, authentication	,	1
	ic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis techniq		
aloo loalii aboat lolollo	of memory or file system artifacts for attack analysis and detection).	1400, 4.14 1.10	
NIE-SCE1	Computer Engineering Seminar Master I	Z	4
	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failu		1
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	ually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subjects the subject is limited by the possibilities of the company to select the subject to the su		
irticles and other profes	sional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The semester.	ie topics are i	new ioi eaci
NIE OOEO			1
NIE-SCE2	Computer Engineering Seminar Master II	Z	4
	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failu		
	ually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is the subject of the subject is the subject of the subject o		
rticles and other profes	sional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The	ne topics are i	new for each
	semester.		1
NIE-SIB	Network Security	Z,ZK	5
_	heoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically about de-		
· · · · · · · · · · · · · · · · · · ·	pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network traffic.		
explanation and practi	cal examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general princip	als of handlin	g detected
	security events (i.e. incident handling and incident response).		
NIE-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
Aim of the course is to	o acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Mode	ling) levels an	d with the
	properties of proper tools. The course covers today recent verification methods, too.		
NIE-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
I	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technol	•	_
	g, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge grap	-	
F	quality assurance.		-,
NIE-SYP	Parsing and Compilers	Z,ZK	5
	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of variou	•	_
rie module bullus upori		s variants and	applications
	of LP nareing and are introduced to enecial applications of pareers, such as incremental and parallel pareing		
NIE TEO	of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.	7 71/	
NIE-TES	Systems Theory	Z,ZK	5
Today, humankind has	Systems Theory s the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the	costs of mar	naging this
Today, humankind has complexity and of ensur	Systems Theory s the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the ing the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of model	costs of mar s that describ	naging this be only those
Today, humankind has complexity and of ensur	Systems Theory s the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the ing the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of model that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorith	costs of mar s that describ	naging this be only those
Today, humankind has complexity and of ensur aspects of the systems	Systems Theory s the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the ing the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of model that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorith the modeling and analysis of complex systems.	e costs of mar s that describ ms that form	naging this be only those the basis for
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