Study plan

Name of study plan: Master specialization Design and Programming of Embedded Systems, in English, 2021

Faculty/Institute/Others: Department: Branch of study guaranteed by the department: Welcome page Garantor of the study branch: Program of study: Informatics 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: The study plan is intended for those students who have been accepted to study since the academic year 2021/2022 // Garant: doc. Ing. Hana Kubátová CSc. . Guarantor: doc. Ing. Hana Kubátová, CSc., email: Hana.Kubatova@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: NIE-PP.21

Name of the group: Compulsory Courses of Master Study Program, Version 2021 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
NIE-KOP	Combinatorial Optimization Petr Fišer, Jan Schmidt Petr Fišer Petr Fišer (Gar.)	Z,ZK	6	3P+1C	Z	PP
NIE-DIP	Diploma Project Robert Pergl Zden k Muziká	Z	30		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

Characteristics of the courses of this group of Study Plan: Code=NIE-PP.21 Name=Compulsory Courses of Master Study Program, Version 2021

NIE-KOP **Combinatorial Optimization** Z,ZK 6 The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems. NIE-DIP **Diploma Project** Ζ 30 NIE-MPR Ζ Master Project 7 1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. External Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR, MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on

the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of the department responsible for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.

NIE-MPI	Mathematics for Informatics	Z,ZK	7
The course focuses on s	elected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-vari	iate analysis, smo	oth optimization,
and multi-variate integra	ation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. Th	e last topic inclue	des selected
numerical algorithm and	I their stability analysis. The topics are completed with the demonstration of applications in computer science. The course foc	uses on clear pre	sentation and
argumentation.			
NIE-PDP	Parallel and Distributed Programming	Z,ZK	6
21st century in compute	r architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cor	es. Parallel comp	uting systems
are becoming a ubiquite	ous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platfi	orms. Students g	et acquainted
with architectures of pa	rallel and distributed computing systems, their models, theory of interconnection networks and collective communication oper	ations, and langu	lages and
environments for paralle	el programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and c	on selected proble	ems, they will
learn the techniques of	design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The cour	rse includes a ser	mester project of
practical programming i	n 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, indep	endence test; Ra	ndom processes
- stacionarity; Markov cl	nains and limiting properties; Queuing theory		
Name of the b	lock: Povinné p edm ty specializace		

Minimal number of credits of the block: 35 The role of the block: PS

Code of the group: NIE-PS-NPVS.21

Name of the group: Compulsory Courses of Master Spec. Design and Programming of Embedded Systems, v. 2021, in Czech

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

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

Credits in the group: 35

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NIE-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-BVS	Embedded Security Martin Novotný Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	PS
NIE-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-TES	Systems Theory Tomáš Kolárik, Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-TSP	Testing and Reliability Petr Fišer Petr Fišer Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NIE-PS-NPVS.21 Name=Compulsory Courses of Master Spec. Design and Programming of Embedded Systems, v. 2021, in Czech

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 (Transaction Level Mod	odeling) levels a	nd with the
properties of proper tools. The course covers today recent verification methods, too.		
NIE-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 I	base of advance	ed embedded
systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,	, including stan	dardized means
of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NIE-BVS Embedded Security	Z,ZK	5
Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of crypt	tographic primit	ives in hardware
and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resource	es for securing in	nternal functions
of computer systems.		
NIE-ESW Embedded Software	Z,ZK	5
Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the backware course acquainted students with the specifics of software development for embedded systems.	asic techniques	of programming
in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up	o to sophisticate	ed techniques
combined with artificial intelligence.		
NIE-BKO Error Control Codes	Z,ZK	5
The course expands the basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mathematical systems for error detection and correction.	matical theory a	and principles of
linear, cyclic codes and codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to implement	nent these detection	ctions and
corrections for different types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channels.		

Today, humankind has the complexity and of ensuring aspects of the systems the the modeling and analysis NIE-TSP T Students will gain knowled the intuitive path sensitizat	bystems Theory ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplain of the correct behavior of a given system have become critical. A key technique for master at are important for the task at hand, and automated tools for analyzing those models. The of complex systems. Testing and Reliability lige about circuit testing and about methods for increasing reliability and security. They we tion and to use an ATPG for automatic test generation. They will be able to design easily malyze, and control the reliability and availability of the designed circuits.	ering this complex his subject will pre vill get practical ski	ity is the usa sent theory	owever, the age of mode and algoriti	els that describents that form the form	e only those he basis for 5 the help of
	ck: Elective courses of credits of the block: 0 block: V					
Name of the gro Embedded Syst Requirement cro	up: NIE-NPVS-VS.21 oup: Elective Vocational Courses for Master Special ems edits in the group: urses in the group:	ization Des	sign an	d Prog	ramming	of
Credits in the gr	ö					
Note on the grou	•	lizations with	the exc	eption o	f this speci	alization
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
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-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-PIS	Advanced Information Systems Petr Kroha, Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz Róbert Lórencz Martin Jure ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ADP	Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (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 Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-ADM	Data Mining Algorithms Pavel Kordík, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-DSV	Distributed Systems and Computing Jan Jane ek, Pavel Tvrdík, Peter Macejko Peter Macejko Jan Jane ek (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 Jan Holub (Gar.)	Z,ZK	5	2P+1C	z	V
NIE-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan Stefan Ratschan (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 Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-HWB	Hardware Security Jií Bu ek Jií Bu ek Jií 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-AM1	Middleware Architectures 1 Milan Doj inovski, Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	z	V
NIE-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha 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 Simona Forn sek Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	L	V

NIE-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	V
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-REV	Reverse Engineering Josef Kokeš, Ji í Dostál Ji í Dostál Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	V
NIE-SBF	System Security and Forensics Simona Forn sek Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-VCC	Virtualization and Cloud Computing Jan Fesl, Tomáš Vondra Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
	courses of this group of Study Plan: Code=NIE-NPVS-VS.21 N	lame=Electiv	e Vocati	onal Cou	rses for N	laster
	and Programming of Embedded Systems			7	,ZK	5
	vanced Cryptology tials of cryptanalysis and the mathematical principles of constructing symmetric and a	symmetric cinher	e They will	1		-
	They will have an overview of cryptanalysis methods, elliptic curve cryptography and q		-			-
s and a second sec	reation of their own software solutions.	dantan oryptogre	ipity, which	andy barr app		gration of
				7	,ZK	5
	vanced Database Systems	م بينغة معيد م	naanta of i		·	-
	n problems of evaluation and optimization of SQL queries. The next part of the course		-			
	new data models (XML, graph databases, column databases) and languages for work		luery, XPat	n, CYPHER,	Gremiin). In	le last part of
· · ·	nance evaluation of database machines. This course is equivalent to the course MIE-P	DB.				
NIE-PIS Adv	vanced Information Systems			Z	,ZK	5
Students learn the notion of b	pusiness process logic and its formalization, with business process roles, business rule	s, and data proce	ssing, with	the notion of	service orier	ited company,
enterprise services and servi	ice solution of business logic. They get acquainted with these notions also for the othe	r types of ISs. The	ey learn ab	out agility and	d adaptivity a	and using of
artificial intelligence methods	s for implementation of these ideas in ISs. They understand modern object-oriented me	thodologies for n	nodelling of	business pro	ocesses, bus	iness rules,
processed data, and enterpri	ise ISs. They will get the rules and technologies for successful implementation of IS.					
NIE-AIB Alg	orithms of Information Security			7	,ZK	5
	with the algorithms of secure key generation and cryptographic error (not only biometric) data processing.	Furthermo	1		-
	rotocols (identification, authentication, and signature schemes). Another part of the co					
learning in detection systems	s. The last topic includes practical steganographic methods and attacks on steganogra	phic systems.				
NIE-ADP Arc	hitecture and Design patterns			Z	.ZK	5
-	s to provide students with both work knowledge about the underlying foundations of o	oject-oriented des	ign and an		,	erstanding of
	radeoffs of advanced software design. In the first part of the course, the students will re					
and get familiar with the comr	monly used object-oriented design patterns that represent the best practices for solving	common softwar	e design pr	oblems. In the	e second par	t the students
will be introduced to the princ	iples of software architecture design and analysis. This includes the classical architectu	ral styles, compoi	nent based	systems, and	d some adva	nced software
architectures used in large-so	cale distributed systems.					
NIE-MVI Cor	mputational Intelligence Methods			Z	,ZK	5
	basic methods and techniques of computational intelligence, which are based on trad	itional artificial int	elligence, a	ire parallel in	nature and a	are applicable
	blems. The subject is also devoted to modern neural networks and the ways in which th		oevolution.	Students wil	l learn how th	nese methods
work and how to apply them	to problems related to data extraction, management, intelligence in games and optimis	sation, etc.				
NIE-KOD Dat	ta Compression			Z	,ZK	5
	ta Compression he basic principles of data compression. They will learn the necessary theoretical back	ground and get a	n overview	1	· I	-
Students are introduced to th				of data comp	pression met	hods being
Students are introduced to the used in practice. The overview	he basic principles of data compression. They will learn the necessary theoretical back			of data comp	pression met	hods being
Students are introduced to the used in practice. The overview lossy data compression meth	he basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor			of data comp on, students	pression met	hods being
Students are introduced to the used in practice. The overview lossy data compression mether NIE-ADM Date	he basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor nods used in image, audio, and video compression.	npression method	ds. In additi	of data comp on, students	,ZK	hods being adamentals of 5
Students are introduced to the used in practice. The overview lossy data compression mether NIE-ADM Date The course focuses on algorithm	he basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor nods used in image, audio, and video compression. ta Mining Algorithms	npression method	ds. In addition	of data comp on, students Z	,ZK	hods being idamentals of 5 chine learning
Students are introduced to the used in practice. The overview lossy data compression methem NIE-ADM Date The course focuses on algorit basics. The emphasis is put of methods).	ne basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor hods used in image, audio, and video compression. ta Mining Algorithms ithms used in the fields of machine learning and data mining. However, this is not an ir	npression method	ds. In addition	of data comp on, students Z	,ZK	hods being idamentals of 5 chine learning
Students are introduced to the used in practice. The overview lossy data compression mether NIE-ADM Date The course focuses on algorit basics. The emphasis is put comethods).	ne basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor hods used in image, audio, and video compression. ta Mining Algorithms ithms used in the fields of machine learning and data mining. However, this is not an ir	npression method	ds. In addition	of data comp on, students Zutudents shou ation systems	,ZK	hods being idamentals of 5 chine learning
Students are introduced to the used in practice. The overview lossy data compression methors with the course focuses on algorit basics. The emphasis is put of methods). NIE-DSV Disterview	ne basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor nods used in image, audio, and video compression. ta Mining Algorithms ithms used in the fields of machine learning and data mining. However, this is not an ir on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learn	npression method troductory course ing tasks (e.g., re	ds. In additi	of data comp on, students Z tudents shou ation systems Z	,ZK , and model	hods being damentals of 5 chine learning s (e.g., kernel 5
Students are introduced to the used in practice. The overview lossy data compression methors with NIE-ADM Data The course focuses on algorit basics. The emphasis is put of methods). NIE-DSV Disserver Students are introduced to method to method.	ne basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor nods used in image, audio, and video compression. ta Mining Algorithms ithms used in the fields of machine learning and data mining. However, this is not an ir on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learn tributed Systems and Computing	npression method troductory course ing tasks (e.g., re rministic time resp	e, and the s commendation	of data comp on, students tudents shou ation systems Z omputing proc	,ZK ,ZK ,IId know made ,) and model ,ZK ,xesses and co	hods being damentals of 5 chine learning s (e.g., kernel 5 ommunication
Students are introduced to the used in practice. The overview lossy data compression methors with NIE-ADM Data The course focuses on algorit basics. The emphasis is put of methods). NIE-DSV Disserver Students are introduced to method to method.	ne basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor nods used in image, audio, and video compression. ta Mining Algorithms ithms used in the fields of machine learning and data mining. However, this is not an ir on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learn tributed Systems and Computing ethods for coordination of processes in distributed environment characterised by nondete lgorithms that assure correctness of computations realized by a group of loosely coupl	npression method troductory course ing tasks (e.g., re rministic time resp	e, and the s commendation	of data comp on, students itudents shou ation systems Z omputing proc ms that supp	,ZK ,ZK ,IId know made ,JA model ,ZK ,ZK ,2K ,2K	hods being damentals of 5 chine learning s (e.g., kernel 5 ommunication
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Students are introduced to the used in practice. The overview lossy data compression methods NIE-ADM Date the the the the the the the the the t	ne basic principles of data compression. They will learn the necessary theoretical back w covers principles of integer coding and of statistical, dictionary, and context data cor nods used in image, audio, and video compression. ta Mining Algorithms ithms used in the fields of machine learning and data mining. However, this is not an ir on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learn tributed Systems and Computing ethods for coordination of processes in distributed environment characterised by nondete lgorithms that assure correctness of computations realized by a group of loosely coupl y in case of failures.	npression method atroductory course ing tasks (e.g., re rministic time resp ed processes and	ds. In addition e, and the s ecommendation nonses of cc I mechanis	of data comp on, students tudents shou ation systems Z omputing proc ms that supp	ZK ,ZK ,ZK ,ZK ,ZK ,ZK ,ZK ,ZK	hods being idamentals of 5 chine learning s (e.g., kernel 5 ommunication lability of both 5
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NIE-HWB Hardware Security	Z,ZK	5
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu	-	-
using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stu	-	owledge about
the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the c		
NIE-MKY Mathematics for Cryptology	Z,ZK	5
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers		
on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of disc factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.	rete logarithm. The	problem of
	7 71/	F
NIE-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 sy	Z,ZK	5
architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous c		
of applications. This course replaces the course MIE-MDW.		anightavallability
NIE-MTI Modern Internet Technologies	Z,ZK	5
Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquainted with rou	1 1	-
technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.	3	
NIE-MCC Multicore CPU Computing	Z,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations of		
and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of a		
techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of mult	i-core CPUs and m	nemory interface
throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		
NIE-SIB Network Security	Z,ZK	5
The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically	about detection an	d defense. The
course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network to		
explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general	principals of hand	ling detected
security events (i.e. incident handling and incident response).		
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 me		
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The unit least the continuous problems by direct and iterative algorithms. They will also learn to implement	-	-
linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement as well as in parallel.	ent these algorithm	is sequentially
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 engine	1	-
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related	-	
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called element	s. 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 stal	bility and entropy-re	elated principles.
This knowledge allows students to realize new levels of evolvability in software architectures.		
NIE-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.		
NIE-REV Reverse Engineering	Z,ZK	5
Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of exec		
libraries). Special attention will be paid to C ++. Students will also become familiar with the principles of debugging tools, disassemblers and obfusc	ation methods. Fin	ally, the course
will focus on code compression and decompression and executable file reconstruction.		_
NIE-SBF System Security and Forensics	Z,ZK	5
Students will be introduced to various aspects of system security (principles of endpoint security, principles of security policies, security models, authorized as a teal for investigating approximation in a security insidents (teal principles of security policies, security models, authorized as a teal for investigating approximation in a security insidents (teal principles of security policies) as a teal for investigating approximation is a security insident (teal principles of security policies).		
also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis of memory or file system artifacts for attack analysis and detection).	s techniques, and t	ine importance
NIE-NUR User Interface Design	Z,ZK	5
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, for	1	
notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able		
NIE-VCC Virtualization and Cloud Computing	Z,ZK	5
Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies ar		
acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to ef	-	
performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effect		-
management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical sk		-
and development tools (Continuous integration and development).		-

Code of the group: NIE-V.21 Name of the group: Purely Elective Master Courses, Version 2021 Requirement credits in the group: Requirement courses in the group: Credits in the group: 0 Note on the group: In addition to courses from this group, students

In addition to courses from this group, students can enroll in courses from the group "Elective vocational courses for this specialization". Courses of this group that a student has completed in the bachelor study at CTU cannot be re-completed.

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
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
BIE-CCN	Compiler Construction Christoph Kirsch Christoph Kirsch (Gar.)	Z,ZK	5	3P	L	V
NIE-CPX	Complexity Theory Dušan Knop	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 Alois Pluhá ek (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
NIE-KOD	Data Compression Jan Holub Jan Holub (Gar.)	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-DID	Digital drawing Denisa S vová, Eliška Novotná Denisa S vová Denisa S vová (Gar.)	Z	2	4C	Z,L	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub 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 Alena Šolcová (Gar.)	Z,ZK	3	2P+1C	z	V
NIE-DVG	Aleria Socova Aleria Socova Aleria Socova (Gal.) Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
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 Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-PAM	Parameterized Algorithms Ond ej Suchý	Z,ZK	4	2P+1C	L	V
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ROZ	Pattern Recognition Michal Haindl	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	Advanced machine learning 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	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Martin Barus (Gar.)	KZ	5	2P+1C	Z	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 Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
MI-SCE1	Computer Engineering Seminar Master I 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 Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-BPS	Wireless Computer Networks Alexandru Moucha 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

Characteristics of the courses of this group of Study Plan: Code=NIE-V.21 Name=Purely Elective Master Courses, Version 2021

NIE-MVI Computational Intelligence Methods

Z,ZK 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.

5

NIE-KOD	Data Compression	Z.ZK	5
Students are introduce	to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of d	1 7	-
used in practice. The ov	erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s	students learn the	fundamentals of
	methods used in image, audio, and video compression.	1	
NIE-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 at the knowledge in design of applications that utilize pattern matching.	ccess time and me	mory complexity.
NIE-SYP	Parsing and Compilers	Z,ZK	5
	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge	1 1	-
	troduced to special applications of parsers, such as incremental and parallel parsing.		
NIE-BLO	Blockchain	Z,ZK	5
	d the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain pla	-	-
	re decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place		
· ·	ockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares ttion of blockchain-based solutions in both academia and business.	the students for in	nplementing of
BIE-CCN	Compiler Construction	Z,ZK	5
	lass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principle	1 1	1
understand the design	and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching them	e of the class.	
NIE-CPX	Complexity Theory	Z,ZK	5
	It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of	the theory concern	ning practical
(in)tractability of difficul		7 71/	4
NIE-VYC	Computability rsive functions and effective computability.	Z,ZK	4
NIE-ARI	Computer arithmetic	Z,ZK	4
	bus data representations used in digital devices and will be able to design arithmetic operations implementation units.	ا <u>ک</u> ,۲۲	-
NIE-SCE1	Computer Engineering Seminar Master I	Z	4
The Seminar of Compu	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistan	ce to failures and a	attacks. Students
	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	-	
	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	chers. The topics	are new for each
semester. NIE-SCE2	Computer Engineering Seminer Mester II	Z	4
	Computer Engineering Seminar Master II er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistar		-
	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of		
	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea		
semester.			
NI-DSW	Design Sprint	Z	2
	ojects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to va	alidated prototype i	in 5 days. During
	will get tamiliar with the method as participants. I brough practical challenges they will try the whole 5 day process starting t	with research and	
testing the prototypes (will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting blus final presentation).	with research and	
testing the prototypes (NI-DID	plus final presentation).	with research and	
NI-DID		Z	finishing with
NI-DID The course will introduc they will practically app	blus final presentation). Digital drawing the students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p y in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The cou-	Z perspective and co urse is fit for anyon	finishing with 2 Ior theory, which
NI-DID The course will introduc they will practically app practice or learn drawin	blus final presentation). Digital drawing the students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p y in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The cou- g and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice g	Z perspective and co urse is fit for anyon ained knowledge.	finishing with 2 lor theory, which he who wants to
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NIE-PML Personalized Machine Learning	Z,ZK	5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteris	stics and behavior	s of individual
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal inte	erests, its principle	s 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 th	eoretical, algorithr	nic, and practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.		
NI-AML Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of	f 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 discuss	ed.
NIE-PDL Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine	learning framewo	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 su	uch as computer v	ision and natural
language processing.		
NIE-VPR Research Project	Z	5
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 partia	-	-
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		
Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the		
MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the		
the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the he		
for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for		•
aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.		
NIE-SWE Semantic Web and Knowledge Graphs	Z,ZK	5
The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to	1 1	1
practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	•	
quality assurance.	Je 3. epe ee	
MI-SCE1 Computer Engineering Seminar Master I	Z	4
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistan	1	attacks. Students
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of		
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 tea	-	
semester.		
NIE-HSC Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical atta	acks. 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 a	nd get familiar wit	h higher-order
attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel inform	nation leakage.	0
NIE-DDW Web Data Mining	Z.ZK	5
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gair	1 '	-
techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an over		
in the field of social web and recommendation systems.		
NIE-BPS Wireless Computer Networks	Z.ZK	4
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in	1 '	multicast and
broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get know		
for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.		,
MIE-SEP World Economy and Business	Z,ZK	4
The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries an	1 1	1 -
Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedo		-
development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on i		
take bachelor level of this course BIE-SEP as a prerequisite.		

List of courses of this pass:

Code	Name of the course	Completion	Credits
BIE-CCN	Compiler Construction	Z,ZK	5
This is an introdu	ctory class on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles	of compilers for st	udents to
understa	nd the design and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching	theme of the class	S.
MI-SCE1	Computer Engineering Seminar Master I	Z	4
The Seminar of Co	nputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	failures and attac	ks. Students
are approached in	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the	subject is work wi	th scientific
articles and other p	rofessional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher	s. The topics are n	ew for each
	semester.		
MIE-MZI	Mathematics for data science	Z,ZK	4
In this course, the	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 Economy and Business	Z,ZK	4
The course introd	ces students of technical university to the international business. It does that predominantly by comparing individual countries and k	ey regions of world	d economy.
Students get to	know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedor	n, corruption and e	economic
development, whic	h are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv	idual readings. It is	s advised to
	take bachelor level of this course BIE-SEP as a prerequisite.		

NI-AML	Advanced machine learning	Z,ZK	5
The course introduc	ces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of rec		ems, 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 discus	ssed.
NI-DID	Digital drawing	Z	2
	oduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, persp		-
	apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course		
	r learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practi	ce gained knowled	-
NI-DSW	Design Sprint	<u> </u>	2
	on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to valida udents will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting wit		
	testing the prototypes (plus final presentation).		Shiriy with
NI-GLR	Games and reinforcement learning	Z,ZK	4
	cement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelliger		•
	give you both theoretical and practical background so you can participate in related research activities. Presented in Englis		
NI-GRI	Grid Computing	Z,ZK	5
	Grid computing and gain knowledge about the world-wide network and computing infrastructure.	_,	•
NIE-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses	s on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students	· · ·	ine learning
basics. The empha	sis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation sys	tems) and models	(e.g., kernel
	methods).		
NIE-ADP	Architecture and Design patterns	Z,ZK	5
	is course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as		-
-	ues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of		
e e	h the commonly used object-oriented design patterns that represent the best practices for solving common software design problems.		
will be introduced to	b the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems architectures used in large-scale distributed systems.	, and some advanc	ed software
NIE-AIB		774	F
	Algorithms of Information Security quainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, stude	Z,ZK	5 athematical
	tographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection		
	learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic syste		maonino
NIE-AM1	Middleware Architectures 1	Z,ZK	5
	dy new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syste		
	lication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm		
	of applications. This course replaces the course MIE-MDW.		
NIE-AM2	Middleware Architectures 2	Z,ZK	5
			0
Students will learn	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture		-
			-
Students will learn	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. Computer arithmetic	es, concepts and te	-
NIE-ARI	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. Computer arithmetic Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementa	es, concepts and te Z,ZK tion units.	echnologies 4
NIE-ARI NIE-BKO	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. Computer arithmetic Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementa Error Control Codes	z,ZK tion units. Z,ZK	echnologies 4 5
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-	Embedded Hardware	Z,ZK	5
	s 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 standard	ized means
	of internal communication, parallelism extraction and utilization in special structures and system architectures.	771	
NIE-EPC	Effective C++ programming v to use the modern features of contemporary versions of the C++ programming language for software development. The course focus	Z,ZK	5
	ficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor t		ig enectivity
NIE-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 ba	'	-
	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up		
	combined with artificial intelligence.		
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get know	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access	s time and memory	complexity.
	They will be able to use the knowledge in design of applications that utilize pattern matching.		
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 so	ftware tools that all	ow to prove
	basic properties of software.	774	
NIE-GAK	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.	Z,ZK	5
	e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top		
-	theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory w		
·····g, ······	of combinatorics on words, formal languages and bioinformatics.		
NIE-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain I	snowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI		nvironment,
which is already a v	videspread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com	putational structure	es, students
	will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.		
NIE-HMI	History of Mathematics and Informatics	Z,ZK	3
	es on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer sci		
	ome relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science		
NIE-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 attack ide channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and	-	
	They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel	-	-
NIE-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	I ' I	-
	eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studen	-	-
41			
the cr	yptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions	s of the computer.	-
NIE-KOD	ptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions Data Compression	s of the computer.	5
NIE-KOD Students are intro	Data Compression oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data	Z,ZK compression meth	ods being
NIE-KOD Students are intro	Data Compression oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data the overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude	Z,ZK compression meth	ods being
NIE-KOD Students are intro used in practice. T	Data Compression oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data he overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude lossy data compression methods used in image, audio, and video compression.	Z,ZK compression meth ents learn the fund	ods being amentals of
NIE-KOD Students are intro used in practice. T NIE-KOP	Data Compression oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data he overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude lossy data compression methods used in image, audio, and video compression. Combinatorial Optimization	Z,ZK compression meth ents learn the fund Z,ZK	amentals of
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NIE-KOD Students are intro used in practice. T NIE-KOP The students will	Data Compression oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data he overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude lossy data compression methods used in image, audio, and video compression. Combinatorial Optimization 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.	Z,ZK compression methents learn the fundation Z,ZK y to select and imp	amentals of 6 lement but
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NIE-MTI Modern Internet Technologies	Z,ZK	5
Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquainted with	routing techniques and	l 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	Z,ZK	5
Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are p	1 / 1	-
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. Stu		se methods
work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation		
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 me		
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 implem	ent these algorithms s	equentially
as well as in parallel.		
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 engine		-
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related		
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called element		
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stal		
This knowledge allows students to realize new levels of evolvability in software architectures.	ing and onliopy folato	a principieer
	Z.ZK	5
NIE-NUR User Interface Design	1 ' 1	-
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, for		
notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be	-	
NIE-PAM Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often ne	cessary 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. Ofter	one can find a commo	on property
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exp	onentially 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 polynom	al time preprocessing of	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 so	lution 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	ι (presumably) does no	t exist. We
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approxim		
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 data	· · · · · ·	
databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, C		
the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PI		abi part of
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	-	-
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields si	ich as computer vision	and natural
language processing.		
NIE-PDP Parallel and Distributed Programming	Z,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 of	ores. Parallel computin	ig systems
are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these pl	atforms. Students get a	cquainted
with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication	operations, and langua	iges and
environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms ar	d on selected problem	s, they will
learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The con	urse includes a semeste	er project of
practical programming in OpenMP and MPI for solving a particular nontrivial problem.		
NIE-PIS Advanced Information Systems	Z,ZK	5
Students learn the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the r	· · ·	
enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about		
artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of bu	• • • • •	•
processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS.	-	
NIE-PML Personalized Machine Learning	Z,ZK	Б
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Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characte		
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal inter-		
to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from the	-	ind practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial con		
NIE-REV Reverse Engineering	Z,ZK	5
Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of exe	cutable 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 obfuse	ation methods. Finally,	the course
will focus on code compression and decompression and executable file reconstruction.		
NIE-ROZ Pattern Recognition	Z,ZK	5
The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the	e statistical approach t	o pattern
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation	n, and their numerical a	aspects.
NIE-SBF System Security and Forensics	Z,ZK	5
Students will be introduced to various aspects of system security (principles of endpoint security, principles of security policies, security models, auti		
also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analys		
of memory or file system artifacts for attack analysis and detection).	1	1
NIE-SCE1 Computer Engineering Seminar Master I	Z	4
	1 1	
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistan		
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part o	-	
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 tea	oners. The topics are n	ew IOI each
semester.		

NIE-SCE2	Computer Engineering Seminar Master II	Z	4			
The Seminar of Co	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	failures and attack	s. Students			
are approached in	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the	subject is work wit	h 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.					
NIE-SIB	Network Security	Z,ZK	5			
	ain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically about					
•	basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network tra					
	practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general pri					
	security events (i.e. incident handling and incident response).	5				
NIE-SIM	Digital Circuit Simulation and Verification	Z,ZK	5			
	e is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level M		-			
	properties of proper tools. The course covers today recent verification methods, too.	Sacing) levels and	with the			
NIE-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5			
-	learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web tech	· · ·				
	Jelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	. .				
practices for mod	quality assurance.	Jiapins and their sy	ysternatic			
		7 71				
NIE-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 va	rious variants and a	applications			
	of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.					
NIE-TES	Systems Theory	Z,ZK	5			
Today, humankin	d has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However,	, the costs of mana	aging this			
complexity and of e	ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of mo	odels that describe	only those			
aspects of the syst	tems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algo	prithms that form th	ne basis for			
	the modeling and analysis of complex systems.					
NIE-TSP	Testing and Reliability	Z,ZK	5			
Students will gain I	knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to pred	are a test set with	the help of			
the intuitive path se	ensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with bui	it-in-self-test equip	ment. 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	5			
	n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	· ·	-			
-	rtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficient	-				
	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective					
	mplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in		-			
0	and development tools (Continuous integration and development).		° I			
NIE-VPR	Research Project	7	5			
	g of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tas	- 1	-			
	er. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end					
Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR,						
MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on						
,	the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of					
for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should						
	aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.	s apooning contee				
		7.71	7			
NIE-VSM	Selected statistical Methods	Z,ZK				
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					
NIE-VYC	Computability	Z,ZK	4			
	Classical theory of recursive functions and effective computability.					

For updated information see <u>http://bilakniha.cvut.cz/en/FF.html</u> Generated: day 2024-05-18, time 10:34.