Study plan

Name of study plan: Master specialization Computer Science, 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. . Guarantor: prof. Ing. Jan Holub, Ph.D., email: jan.holub@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 Zden k Muziká Zden k Muziká (Gar.)	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 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 k	nowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not of	only to select and	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	ne 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 t	he requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the er	nd of the semeste	r. 2. The external
supervisor enters the ir	formation on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.	cz/student/studijn	i/formulare). The
completed and signed f	orm 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 to	opic that the stude	ent has reserved
is rather general, the in	mediate 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 c	complete and
approvable at the end of	f the semester.		
NIE-MPI	Mathematics for Informatics	Z,ZK	7
The course focuses on a	selected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-var	iate analysis, smo	ooth optimization,
and multi-variate integr	ation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The	ne last topic inclue	des selected
numerical algorithm an	d their stability analysis. The topics are completed with the demonstration of applications in computer science. The course for	uses on clear pre	esentation 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 col	res. Parallel comp	uting systems
are becoming a ubiquito	us commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platf	orms. Students ge	et acquainted
with architectures of par	allel and distributed computing systems, their models, theory of interconnection networks and collective communication ope	rations, and langu	ages and
environments for paralle	I programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and	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 cou	rse includes a ser	nester project of
practical programming in	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, independence test; Random processes - stacionarity; Markov chains and limiting properties; Queuing theory

Name of the block: Compulsory courses in the specialization Minimal number of credits of the block: 35 The role of the block: PS

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

Name of the group: Mgr. Specialization Computer Science, Version 2021 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-MVI	Computational Intelligence Methods Miroslav epek, Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-ADM	Data Mining Algorithms Rodrigo Augusto Da Silva Alves Rodrigo Augusto Da Silva Alves Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	PS
NIE-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	PS
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NIE-TI-PS.21 Name=Mgr. Specialization Computer Science, Version 2021

NIE-MVI	Computational Intelligence Methods	Z,ZK	5
Students will understan	d the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are pa	arallel in nature ar	nd 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. Stuc	ents will learn how	w these methods
work and how to apply t	hem 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 da	ta compression m	nethods being
used in practice. The ov	erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s	tudents 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 stude	nts should know n	nachine learning
basics. The emphasis is	put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation	systems) and more	dels (e.g., kernel
methods).			
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge	of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both ac	cess time and me	mory complexity.
They will be able to use	the knowledge in design of applications that utilize pattern matching.		
NIE-GAK	Graph theory and combinatorics	Z,ZK	5
The goal of the class is	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith	ms. The emphasis	s will be not only
on undestanding the bas	sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selectec	l topics from graph	and hypergraph
coloring, Ramsey theory	y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo	ry will be also app	lied in the fields
of combinatorics on wo	rds, formal languages and bioinformatics.		
NIE-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introdu	eed to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such met	hods to real-world	d problems. They
will also learn the finite	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. T	hey will learn to se	olve systems of
linear algebraic equatio	ns that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme	nt these algorithm	ns sequentially
as well as in parallel.			

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.					

Name of the block: Elective vocational courses in the branch/specialization Minimal number of credits of the block: 0 The role of the block: VO

Code of the group: NIE-TI-VS.21

Name of the group: Elective Vocational Courses for Master Specialization Computer Science Requirement credits in the group:

Requirement courses in the group:

Credits in the group: 0

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-KRY	Advanced Cryptology Ji í Bu ek, Róbert Lórencz Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	VO
NIE-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-PIS	Advanced Information Systems Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-ADM	Data Mining Algorithms Daniel Vašata, Pavel Kordík, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-ADP	Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-SIM	Digital Circuit Simulation and Verification Martin Kohlik Martin Kohlik Martin Kohlik (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-DSV	Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-BVS	Embedded Security Ji í Bu ek, Martin Novotný Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	VO
NIE-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-BKO	Error Control Codes Pavel Kubalik Pavel Kubalik (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-HWB	Hardware Security Jií Bu ek Jií Bu ek Jií Bu ek (Gar.)	Z,ZK	5	2P+2C	L	VO
NIE-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz, Olha Jure ková Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	VO
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-AM1	Middleware Architectures 1 Tomáš Vitvar, Milan Doj inovski, Jaroslav Kucha Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NI-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	VO
NIE-SIB	Network Security Tomáš Zahradnický, Ji í Dostál, Simona Forn sek, Gramoz Cubreli Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-NSS	Normalized Software Systems Jan Verelst, Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	VO

F		r		1	r	
NIE-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	VO
NIE-SBF	System Security and Forensics Tomáš Zahradnický, Ji í Bu ek, Simona Forn sek, Marián Svetlík Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	Z	vo
NIE-TES	Systems Theory Tomáš Kolárik, Stefan Ratschan, Ji í Vysko il Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	vo
NIE-TSP	Testing and Reliability Petr Fišer Petr Fišer Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	VO
NIE-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	VO
NIE-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	VO
Characteristics of the	courses of this group of Study Plan: Code=NIE-TI-VS.21 Name=E	lective Vocation	onal Cou	rses for N	laster Spe	cialization
Computer Science					•	
NIE-KRY Ad Students will learn the essen	vanced Cryptology tials of cryptanalysis and the mathematical principles of constructing symmetric and a		-	know the ma	-	
-	They will have an overview of cryptanalysis methods, elliptic curve cryptography and c	quantum cryptogra	aphy, which	they can ap	ply to the inte	gration of
	reation of their own software solutions.				71/	<i>r</i>
	vanced Database Systems n problems of evaluation and optimization of SQL queries. The next part of the course	doolo with now o	nanta of a		,ZK	
	new data models (XML, graph databases, column databases) and languages for work				•	
	nance evaluation of database machines. This course is equivalent to the course MIE-F		aciy, Ai au	I, OTTTIER,	Greining. In	
	vanced Information Systems			7	,ZK	5
	business process logic and its formalization, with business process roles, business rule	e and data proce	eeina with t	1	· .	-
	ice solution of business logic. They get acquainted with these notions also for the other	· ·				
	s for implementation of these ideas in ISs. They understand modern object-oriented m					
	ise ISs. They will get the rules and technologies for successful implementation of IS.		J		,	,
	orithms of Information Security			7	,ZK	5
	with the algorithms of secure key generation and cryptographic error (not only biometric) data processing	Furthermo			-
	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.				
NI-ADM Da	ta Mining Algorithms			Z	,ZK	5
The course focuses on algor	ithms used in the fields of machine learning and data mining. However, this is not an in	ntroductory course	e, and the s	tudents shou	uld know mac	hine learning
basics. The emphasis is put of	on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine lear	ning tasks (e.g., re	commenda	tion systems	s) and models	s (e.g., kernel
methods).						
	chitecture and Design patterns				,ZK	5
	s to provide students with both work knowledge about the underlying foundations of o		•			• I
e	radeoffs of advanced software design. In the first part of the course, the students will r					с с
, s	monly used object-oriented design patterns that represent the best practices for solving		• •			
architectures used in large-s	iples of software architecture design and analysis. This includes the classical architectu	arai siyles, compo	lent baseu	Systems, and	u some auvai	iceu sonware
	ital Circuit Simulation and Verification			7	,ZK	5
	aint the students with principles of digital circuit simulation at RTL (Register Transfer Li	evel) and TLM (Tr	ansaction L			
	e course covers today recent verification methods, too.				g) levels and	with the
	tributed Systems and Computing			7	,ZK	5
1 1	ethods for coordination of processes in distributed environment characterised by nondete	erministic time resp	onses of co			
	lgorithms that assure correctness of computations realized by a group of loosely coup					
data and services, and safety	y in case of failures.					
NIE-EPC Eff	ective C++ programming			Z	,ZK	5
Students learn how to use th	e modern features of contemporary versions of the C++ programming language for so	ftware developme	nt. The cou	rse focuses	on programm	ing effectivity
and efficiency in the form of	writing maintainable and portable source code and creating correct programs with low	memory and pro	cessor time	requiremen	ts.	
NIE-EHW Em	bedded Hardware			Z	,ZK	5
The course brings basic laws	s that govern digital design and basic techniques to use them. It deals with both large	and small scale s	stems. This	s is the base	of advanced	embedded
	r specialized structure for effective computation and acceleration. Design of fast custo	m computing mac	hines is dis	cussed, inclu	uding standar	dized means
	arallelism extraction and utilization in special structures and system architectures.					
	bedded Security				,ZK	5
-	ge in selected topics of cryptography and cryptanalysis. The course focuses particularly	-				
	ystems). Students gain a good overview of functionality of (hardware) cryptographic act	beierators, smart o	arus, and fe	esources for	securing inte	nai iunctions
of computer systems.	haddad Saftwara				71/	5
-	Ibedded Software cquainted students with the specifics of software development for embedded systems. The specific set of th		he areas fro		Z,ZK	-
	nizations, through typical areas as the reliable software development, embedded systems.					
combined with artificial intelli		and systems, Si	- iai pi 0085	ong, up to 5		Johnnyuuu
	or Control Codes			7	,ZK	5
	ic knowledge of security codes used in current systems for error detection and correct	ion. It provides the	enecessarv			
	is for the correction of multiple errors, clusters of errors and whole syllables (bytes). Si	-	-		-	
-	s of transmissions (parallel, serial) when storing data in memory and when transmitting			-		
NIE-FME For	mal Methods and Specifications			Z	,ZK	5
	e semantics of software formally and to use sound reasoning for construction of correct	t software. They le	arn to use		· 1	-
basic properties of software.	-	-				

NIE-GPU GPU Architectures and Programming	Z,ZK	5
Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the		ng environment,
which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical	computational stru	ictures, students
will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.		
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 logantinin. The	problem of
NI-MVI Computational Intelligence Methods	Z,ZK	5
Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to	1 1	
how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.		-
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 sy	1 1	web service
architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous of	ommunications and	d high availability
of applications. This course replaces the course MIE-MDW.		
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	ting techniques ar	nd transfer
technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.		
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 o		
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 throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.	I-core CPUs and n	nemory internace
NI-NON Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such me		-
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering.		
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.	Ū	, ,
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	1 '	d defense. The
course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network t	raffic. The course	focuses on
explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general	principals of hand	ling detected
security events (i.e. incident handling and incident response).		
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 engineer		
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.	bility and entropy-re	elated principles.
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	,	
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, auth		ts). Students will
also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis	s techniques, and t	he importance
of memory or file system artifacts for attack analysis and detection).		
NIE-TES Systems Theory	Z,ZK	5
Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However,	ver, the costs of ma	anaging 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		-
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	l algorithms that fo	rm the basis for
the modeling and analysis of complex systems.	7 71/	-
NIE-TSP Testing and Reliability	Z,ZK	5
Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems wit		-
will be able to compute, analyze, and control the reliability and availability of the designed circuits.		equipment. mey
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		-
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	tive technology to	day for the
management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical sk	ills in the use of mo	odern integration
and development tools (Continuous integration and development).		

Code of the group: NIE-V.21 Name of the group: Purely elective master's courses Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

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-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 Star ý 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 (Gar.)	Z	4	2C	Z	V
NIE-SCE2	Computer Engineering Seminar Master II 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	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 (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	V
FITE-EHD	Introduction to European Economic History Tomáš Evan	Z,ZK	3	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 (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 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	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 Karel Klouda (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 (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 (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
NIE-SEP	World Economy and Business Tomáš Evan	Z,ZK	4	2P+1C	Z	V
FITE-SEP	World Economy and Business Tomáš Evan	Z,ZK	4	2P+2C	Z	V
Characteristics of the	ອ courses of this group of Study Plan: Code=NIE-V.21 Name=Pເ	rely elective	master's	courses	5	
	omputational Intelligence Methods				,ZK	5
	e basic methods and techniques of computational intelligence, which are based on trad					
	oblems. The subject is also devoted to modern neural networks and the ways in which th n to problems related to data extraction, management, intelligence in games and optimi	-	roevolution.	Students wi	l learn how th	ese methods
	ficient Text Pattern Matching	34101, 610.		7	"ZK	5
	fficient algorithms for text pattern matching. They learn to use so called succinct data stru	uctures that are ef	ficient in bot		· .	-
s .	knowledge in design of applications that utilize pattern matching.					,,
NIE-SYP Pa	rsing and Compilers			Z	,ZK	5
	knowledge of fundamentals of automata theory, formal language and formal translation th	eories. Students g	gain knowled	lge of variou	is variants and	d applications
	luced to special applications of parsers, such as incremental and parallel parsing.					
	ockchain Gundations of blackabain technology, amort contract programming, and gain on even i				.,ZK	5
	e foundations of blockchain technology, smart contract programming, and gain an overvi- ecentralized application, and assess whether integration of a blockchain is suitable for					U
	hains and information security. It is concluded with a defense of a research or applied s				-	
supervising implementation	of blockchain-based solutions in both academia and business.	• •				
NIE-CPX Co	omplexity Theory			Z	"ZK	5
	e fundamental classes of problems in the complexity theory and different models of algo	oritms and about	implications	of the theor	y concerning	practical
(in)tractability of difficult prol						
	omputability			2	"ZK	4
	e functions and effective computability.			7	"ZK	1
	omputer arithmetic lata representations used in digital devices and will be able to design arithmetic operati	ons implementati	on units	2	.,ZN	4
	omputer Engineering Seminar Master I	ono impiornoman			7	4
I	ngineering is a (s)elective course for students who want to deal with deeper topics of dig	ital design, reliabi	lity and resis	tance to fail		
are approached individually	within the subject. Each student or group of students solves some interesting topic with	n the selected sup	ervisor. Par	t of the subj	ect is work w	ith scientific
	hal literature and/or work in K N laboratories. The capacity of the subject is limited by the	ne possibilities of	the seminar	teachers. T	he topics are	new for each
semester.						
	omputer Engineering Seminar Master II	ital daaiga raliahi	lity and reals	tonoo to foil	Z	4 aka Studanta
	ngineering is a (s)elective course for students who want to deal with deeper topics of dig within the subject. Each student or group of students solves some interesting topic with	-	-			
, ,, ,,	nal literature and/or work in K N laboratories. The capacity of the subject is limited by the					
semester.						
	esign Sprint				Z	2
	ts using the Design Sprint method, developed by Google. THanks to this method the tea	-				
	get familiar with the method as participants. Through practical challenges they will try the	ne whole 5 day pr	ocess starti	ng with rese	earch and finis	shing with
testing the prototypes (plus	gital drawing				Z	2
= . =	udents to the basic principals of digital drawing and graphical design. Students will gain	understanding of	f compositio	 n. perspecti	- 1	
	their own design works. Students will also gain experience in drawing and painting with	-	-			-
practice or learn drawing an	d painting. The course is organized as a thematic practices covering parts of theory an	d practical exercis	se to practic	e gained kn	owledge.	
NI-GLR Ga	ames and reinforcement learning			Z	,ZK	4
	arning is very hot recently, because of advances in deep learning, recurrent neural net	-	al artificial in	telligence. T	his course is	intended to
	d practical background so you can participate in related research activities. Presented i	n English.				<i>г</i>
	id Computing owledge about the world-wide network and computing infrastructure.			2	"ZK	5
	story of Mathematics and Informatics			7	,ZK	3
I	cted topics from calculus, general algebra, number theory, numerical mathematics and	logic - useful for t	odav comp		· .	-
	etween computer science and mathematical methods. Some examples of applications of	-				
NIE-DVG Int	roduction to Discrete and Computational Geometry			Z	,ZK	5
	uce the students to the discipline of Discrete and Computational Geometry. The main ge	cal of the course i	s to get fam	liar with the	most fundam	ental notions
	able to solve simple algorithmic problems with a geometric component.					-
	roduction to European Economic History	dae obout formin	a of the ale		,ZK	3 description
	ection of themes from the European economic history. It gives the student basic knowle As European countries have been dominant actors in this process it focuses predomin	-			-	-
	agmentation of the Middle Ages, from destruction of WWII to the current affairs, the dev	-				
	nomic history of particular European countries but rather the impact of trade and role o	-				
meetings will consist of a mi	ixture of lecture and discussion.					
	athematics for data science				"ZK	4
	are introduced to the domains of mathematics necessary for understanding the standar		-			-
selected notions from proba	 a (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimis bility theory and statistics 	ation with constra	unts, duality	principle, g	radient metho	ous) and
	ddleware Architectures 2			7	"ZK	5
	ds and technologies on the Web including theoretical foundations. They will gain an over	erview of Web apr	lication arc		· · ·	-
	ed cache and databases, smart contracts, realtime communication and web security.				1	

NIE-PAM	Parameterized Algorithms	Z,ZK	4
There are many optimiz	ation problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often nece	ssary to solve the	se problems
exactly in practice. We w	vill demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	one can find a cor	nmon property
(parameter) of the input	s from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exp	onentially in this (s	small) parameter
and polynomially in the	input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomia	al time preprocess	ing 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 solut	ion method. We w	ill present a
plethora of parameterize	ed algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does	s not exist. We
will also not miss out the	e relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.		
NIE-ROZ	Pattern Recognition	Z,ZK	5
The aim of the module i	s to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the s	statistical approac	h to pattern
recognition. Students w	Il learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a	nd their numerical	aspects.
NIE-PML	Personalized Machine Learning	Z,ZK	5
Personalized machine le	arning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteris	tics and behavior	s of individual
entities. While PML is co	ommonly used in applications such as recommender systems, which recommend items to users based on their personal inte	rests, 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 the	eoretical, algorithr	nic, and practical
perspectives. Specifical	y, 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 s	tudents to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of		systems, image
	interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the		
NIE-PDL	Practical Deep Learning	KZ	5
	to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine	1	-
° °	I develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su	•	•
language processing.			
NIE-VPR	Research Project	Z	5
	e semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partia	-	-
	he requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the		
e e	rvisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the		
	n, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award 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		
	B. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student fo	-	-
	g		
aim at fine-tuning the F	I topic so that the FTT will be complete and approvable at the end of the semester.		
-	F topic so that the FTT will be complete and approvable at the end of the semester.	7 7K	
NIE-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
NIE-SWE The students will learn	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to	echnologies, meth	5 nods and best
NIE-SWE The students will learn to practices for modelling,	Semantic Web and Knowledge Graphs	echnologies, meth	5 nods and best
NIE-SWE The students will learn to practices for modelling, quality assurance.	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	echnologies, meth ge graphs and the	5 nods and best r systematic
NIE-SWE The students will learn t practices for modelling, quality assurance. MI-SCE1	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge Computer Engineering Seminar Master I	echnologies, meth ge graphs and the Z	5 nods and best r systematic 4
NIE-SWE The students will learn t practices for modelling, quality assurance. MI-SCE1 The Seminar of Comput	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge Computer Engineering Seminar Master I er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	echnologies, meth ge graphs and the Z ce to failures and a	5 nods and best r systematic 4 attacks. Students
NIE-SWE The students will learn t practices for modelling, quality assurance. MI-SCE1 The Seminar of Comput are approached individu	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge Computer Engineering Seminar Master I er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistant ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	echnologies, meth ge graphs and the Z ce to failures and a the subject is wor	5 nods and best r systematic 4 attacks. Students k with scientific
NIE-SWE The students will learn t practices for modelling, quality assurance. MI-SCE1 The Seminar of Comput are approached individu articles and other profes	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge Computer Engineering Seminar Master I er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	echnologies, meth ge graphs and the Z ce to failures and a the subject is wor	5 nods and best r systematic 4 attacks. Students k with scientific
NIE-SWE The students will learn t practices for modelling, quality assurance. MI-SCE1 The Seminar of Comput are approached individu articles and other profes semester.	Semantic Web and Knowledge Graphs he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge Computer Engineering Seminar Master I er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistant 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 teac	echnologies, meth ge graphs and the Z ce to failures and a the subject is wor chers. The topics	5 nods and best r systematic 4 attacks. Students k with scientific are new for each
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List of courses of this pass:

	Name of the course	Completion	Credits
FITE-EHD	Introduction to European Economic History	Z,ZK	3
	uces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global eco		-
	s in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic	, ,	
	ppire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions and o etailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and o	•	
does not cover de	meetings will consist of a mixture of lecture and discussion.	iganizations in his	5101 y. Class
FITE-SEP	World Economy and Business	Z,ZK	4
	luces students of technical university to the international business. It does that predominantly by comparing individual countries and ke	,	
	know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom		-
development, which	ch 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.		
MI-SCE1	Computer Engineering Seminar Master I	Z	4
	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to		
	ndividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the	-	
articles and other p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester.	s. The topics are r	new for each
MIE-MZI	Mathematics for data science	7 71/	4
	students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in da	Z,ZK	
	inear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ		
monado mainy. n	selected notions from probability theory and statistics.	ipio, gradioni moti	
NI-ADM	Data Mining Algorithms	Z.ZK	5
	s on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students	,	-
	isis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation syst		-
	methods).		
NI-AML	Advanced machine learning	Z,ZK	5
	ces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of rec		
processing,	control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with t	he methods discu	ssed.
NI-DID	Digital drawing	Z	2
	roduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, persp		-
	y 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 practic	-	
NI-DSW	Design Sprint	Z	2
	on projects using the Design Sprint method, developed by Google. Thanks to this method the teams are able to go from idea to validat	tea prototype in 5 d	
	udents will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with	h research and fini	
NI-GLR	testing the prototypes (plus final presentation)	h research and fini	
	testing the prototypes (plus final presentation).		ishing with
	Games and reinforcement learning	Z,ZK	ishing with
		Z,ZK ce. This course is	ishing with
	Games and reinforcement learning rcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen	Z,ZK ce. This course is h.	ishing with
The field of reinfor	Games and reinforcement learning rcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen give you both theoretical and practical background so you can participate in related research activities. Presented in English	Z,ZK ce. This course is	ishing with 4 intended to
The field of reinfor	Games and reinforcement learning recement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen give you both theoretical and practical background so you can participate in related research activities. Presented in English Grid Computing Grid computing and gain knowledge about the world-wide network and computing infrastructure.	Z,ZK ce. This course is h.	ishing with 4 intended to
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The field of reinfor NI-GRI NI-MVI	Games and reinforcement learning reement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen give you both theoretical and practical background so you can participate in related research activities. Presented in English Grid Computing Grid computing and gain knowledge about the world-wide network and computing infrastructure. Computational Intelligence Methods	Z,ZK ce. This course is n. Z,ZK Z,ZK any problems. The	ishing with 4 intended to 5 5
The field of reinfor NI-GRI NI-MVI	Games and reinforcement learning reement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen give you both theoretical and practical background so you can participate in related research activities. Presented in English Grid Computing Grid computing and gain knowledge about the world-wide network and computing infrastructure. Computational Intelligence Methods erstand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to ma	Z,ZK ce. This course is n. Z,ZK Z,ZK any problems. The	4 intended to 5 5
The field of reinfor NI-GRI NI-MVI Students will under NI-NON	Games and reinforcement learning recement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen give you both theoretical and practical background so you can participate in related research activities. Presented in English Grid Computing Grid computing and gain knowledge about the world-wide network and computing infrastructure. Computational Intelligence Methods erstand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to me how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, i	Z,ZK ce. This course is n. Z,ZK Z,ZK any problems. The etc. Z,ZK	ishing with 4 intended to 5 y will learn 5
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NIE-AM1	Middleware Architectures 1	Z,ZK	5
Students will stud	dy new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information systemeters are a set of the set of	em architecture, we	eb service
architecture and ap	lication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm	nunications and hig	h availability
	of applications. This course replaces the course MIE-MDW.	1	
NIE-AM2	Middleware Architectures 2	Z,ZK	5
Students will learn	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture	es, concepts and te	echnologies
	for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.	7 71/	4
NIE-ARI	Computer arithmetic Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementa	Z,ZK	4
NIE-BKO		Z,ZK	5
-	Error Control Codes Is the basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mather		-
	des and codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to imple		
, ,	rections for different types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunica		
NIE-BLO	Blockchain	Z,ZK	5
	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platfor		le to design,
code and deploy a	secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places	an increased emph	nasis on the
relationship betwe	en blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the	students for imple	ementing or
	supervising implementation of blockchain-based solutions in both academia and business.		
NIE-BPS	Wireless Computer Networks	Z,ZK	4
	n about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ac nisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowl		
DIOAUCASI Mecha	for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suital		echanisms
NIE-BVS	Embedded Security	Z,ZK	5
-	c knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of crypt	1 '	-
-	bedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resource:	- · ·	
, , , , , , , , , , , , , , , , , , ,	of computer systems.	Ū	
NIE-CPX	Complexity Theory	Z,ZK	5
Students will lear	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	· · ·	g practical
	(in)tractability of difficult problems.		
NIE-DDW	Web Data Mining	Z,ZK	5
	arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain		
techniques for Web	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie	w of most recent de	evelopments
	in the field of social web and recommendation systems.		
NIE-DIP	Diploma Project	Z	30
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
	uced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing		
channels. They lear	rn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that s data and services, and safety in case of failures.	support night availa	bility of both
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
-	to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with	1 · · ·	-
	of this discipline, and to be able to solve simple algorithmic problems with a geometric component.		
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	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 standard	lized means
	of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NIE-EPC	Effective C++ programming	Z,ZK	5
	v to use the modern features of contemporary versions of the C++ programming language for software development. The course focu		ng effectivity
	iciciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor i		_
NIE-ESW	Embedded Software e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the ba	Z,ZK	5
	d code optimizations, through typical areas as the reliable software development of embedded operating systems, signal processing, u		
	combined with artificial intelligence.	p to sophisticated t	leonniques
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces		1
J. J	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 t	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some so	ftware tools that al	low to prove
	basic properties of software.		
NIE-GAK	Graph theory and combinatorics	Z,ZK	5
-	ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.		
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 t	heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory v	vill be also applied	in the fields
NIE-GPU	of combinatorics on words, formal languages and bioinformatics.	Z,ZK	5
	GPU Architectures and Programming showledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CU	· ·	
-	videspread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com		
will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.			
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 sc		
for finding s	ome relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science	ciences will be sho	wed.

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	•	
various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attack		rder
attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-ch		_
NIE-HWB Hardware Security		5
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safe using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks.		
the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security fu	• •	DOUL
NIE-KOD Data Compression		5
Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of the students are introduced to the basic principles of data compression.	· · · · · ·	-
used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition	•	~ I
lossy data compression methods used in image, audio, and video compression.	.,	
NIE-KOP Combinatorial Optimization	Z,ZK 6	6
The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able in	1 7 1	
also to apply and evaluate heuristics for practical problems.		
NIE-KRY Advanced Cryptology	Z,ZK 5	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will I	know the mathematical principle	es 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	n of
their own systems or to the creation of their own software solutions.		
NIE-MCC Multicore CPU Computing	· · · · ·	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations		
and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of		
techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of me throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these		errace
NIE-MKY Mathematics for Cryptology		5
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphe	1 / 1	-
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		
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems bas	•	
NIE-MPI Mathematics for Informatics		7
The course focuses on selected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-	1 ' 1	
and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation	on. The last topic includes select	ted
numerical algorithm and their stability analysis. The topics are completed with the demonstration of applications in computer science. The course	e focuses on clear presentation	and
argumentation.		
NIE-MPR 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 pa	rtial tasks that should be carried	tuo h
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	e end of the semester. 2. The exte	ternal
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 supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cv	e end of the semester. 2. The externation of the semester. 2. The externation of the semester. 2. The externation of the semester. 2. The second semicondates and the semicondates are semicondates and the semicondates are semicondates ar	ternal). The
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	Advanced Database Systems	Z,ZK	5
databases), with th	emselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database	e machines (so call	ed NoSQL
	ne related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPH	IER, Gremlin). The	last part of
	the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PDB.		
NIE-PDL	Practical Deep Learning	KZ	5
	igned to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine lea	-	-
the course, studen	ts will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such a language processing.	as computer vision	and natural
NIE-PDP	Parallel and Distributed Programming	Z,ZK	6
	mputer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores		-
-	biguitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platfor		
•	es of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication oper	•	· .
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 technique	es of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course	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
	notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion s and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about agili		
	the methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business		•
	processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS.		,
NIE-PML	Personalized Machine Learning	Z,ZK	5
	chine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristic		
	is commonly used in applications such as recommender systems, which recommend items to users based on their personal interest		
to a wide range of o	ther fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theore	-	nd practical
	perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial commu	nities. Z,ZK	
NIE-REV	Reverse Engineering n fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of executal	· · ·	5 bird-party
	attention will be paid to C ++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation		
	will focus on code compression and decompression and executable file reconstruction.		
NIE-ROZ	Pattern Recognition	Z,ZK	5
The aim of the n	nodule is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the sta	atistical approach te	o pattern
-	Idents will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, ar		
NIE-SBF	System Security and Forensics	Z,ZK	5
	roduced to various aspects of system security (principles of endpoint security, principles of security policies, security models, authenti		
	orensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis tec of memory or file system artifacts for attack analysis and detection).	and the in	nportance
NIE-SCE1	Computer Engineering Seminar Master I	Z	4
	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 ir	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 p	professional 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 no	ew for each
	semester.		
NIE-SCE2	Computer Engineering Seminar Master II mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to		-
The Seminal of Co	inputer Engineering is a (s)elective course for students who want to dear with deeper topics of digital design, reliability and resistance to		4 Studente
are approached in	dividually within the subject. Each student or group of students solves some interesting tonic with the selected supervisor. Part of the	o failures and attack	s. Students
	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher	failures and attack subject is work wit	s. Students h scientific
	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester.	failures and attack subject is work wit	s. Students h scientific
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articles and other p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester.	o failures and attack subject is work wit s. The topics are no Z,ZK	s. Students h scientific ew for each 4
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NIE-TSP	Testing and Reliability	Z,ZK	5	
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	5	
Students will gain	n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	organizations. The	y will get	
acquainted with vir	tualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie	ntly operate and o	ptimize the	
performance par	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effecti	ve technology toda	ay for the	
management of cor	nplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in	the use of moderr	n integration	
	and development tools (Continuous integration and development).			
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 partial ta	sks 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 other stress of 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-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				
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 2025-07-05, time 21:55.