Study plan

Name of study plan: Master specialization Software Engineering, 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: 102
Elective courses credits: 18
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: Ing. Michal Valenta, Ph.D., email: michal.valenta@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:

Note on the gr	oup:					
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 Thesis Zden k Muziká 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	only to select and	implement but			
also to apply and evaluation	ate heuristics for practical problems.					
NIE-DIP	Diploma Thesis	Z	30			
NIE-MPR	Master Project	Z	7			
1. At the beginning of th	e 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	ne requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the e	nd of the semeste	r. 2. The external			
supervisor enters the in	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 for	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 t	opic that the stude	ent has reserved			
is rather general, the im	mediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that	t the FTT will be c	complete and			
approvable at the end o	f the semester.					
NIE-MPI	Mathematics for Informatics	Z,ZK	7			
The course focuses on selected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-variate analysis, smooth optimization,						
and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic includes selected						
numerical algorithm and their stability analysis. The topics are completed with the demonstration of applications in computer science. The course focuses on clear presentation and						
argumentation.	argumentation.					

NIE-PDP	Parallel and Distributed Programming	,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 co	res. Parallel comp	uting systems			
are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted						
with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and						
environments for paralle	el 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 i	n OpenMP and MPI for solving a particular nontrivial problem.					
NIE-VSM	Selected statistical Methods	Z,ZK	7			
Summary of probability	many of probability theory. Multivariate normal distribution: Entropy and its application to coding: Statistical tests: Tracts, goodness of fit tests, independence test: Pandom 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-SI-PS.21

Name of the group: Compulsory Courses of Master Specialization Software Engineering, 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-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-PIS	Advanced Information Systems Petr Kroha, Petra Pavlí ková Petra Pavlí ková Petr Kroha (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-ADP	Architecture and Design patterns Ji í Borský Ji í Borský Filip K ikava (Gar.)	Z,ZK	5	2P+1C	z	PS
NIE-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-AM1	Middleware Architectures 1 Tomáš Vitvar, Milan Doj inovski, Jaroslav Kucha Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-NSS	Normalized Software Systems Jan Verelst, Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	PS
NIE-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NIE-SI-PS.21 Name=Compulsory Courses of Master Specialization Software Engineering, v.2021, in Czech

Contrare Engineer					
NIE-PDB	Advanced Database Systems	Z,ZK	5		
Students orient themselv	res in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of datab	ase machines (so	called NoSQL		
databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of					
the course deals with pe	rformance evaluation of database machines. This course is equivalent to the course MIE-PDB.				
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 n	otion of service or	iented company,		
enterprise services and	service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about a	gility and adaptivit	ty and using of		
artificial intelligence meth	nods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of busi	ness processes, b	ousiness rules,		
processed data, and enter	erprise ISs. They will get the rules and technologies for successful implementation of IS.				
NIE-ADP	Architecture and Design patterns	Z,ZK	5		
	rse is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis	s as well as with u	inderstanding of		
the challenges, issues, a	nd tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowled	je of object-orient	ed programming		
and get familiar with the o	commonly used object-oriented design patterns that represent the best practices for solving common software design problem	ns. In the second r	part the students		
will be introduced to the p	principles of software architecture design and analysis. This includes the classical architectural styles, component based syste	ems, and some ad	vanced software		
architectures used in larg	ge-scale distributed systems.				
NIE-FME	Formal Methods and Specifications	Z,ZK	5		
Students are able to des	cribe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some	software tools th	at allow to prove		
basic properties of softw	are.				
NIE-AM1	Middleware Architectures 1	Z,ZK	5		
Students will study new t	rends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information sys	stem architecture,	web service		
architecture and aplicatio	n servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d high availability		
of applications. This cour	se replaces the course MIE-MDW.				
NIE-NSS	Normalized Software Systems	ZK	5		
Students will learn the fo	undations of normalized systems theory that studies the evolvability of modular structures based on concepts from enginee	ring, such as stab	ility from system		
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software					
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core					
functionality of informatio	n systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stab	ility and entropy-re	elated principles.		
This knowledge allows st	tudents to realize new levels of evolvability in software architectures.				

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, formal user models, the fundamental					
notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs.					

Name of the block: Compulsory elective courses Minimal number of credits of the block: 4 The role of the block: PV

Code of the group: NIE-PV-SI.21

Name of the group: Compulsory Elective Master Courser for Specialization Software Engineering, version 2021

Requirement credits in the group: In this group you have to gain at least 4 credits (at most 14) Requirement courses in the group: In this group you have to complete at least 1 course (at most 3) Credits in the group: 4

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-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl Petra Pavlí ková Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	PV
NIE-MEP	Modelling of Enterprise Processes Robert Pergl Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	PV
NIE-TSW	Software Product Development Petra Pavlí ková Petra Pavlí ková Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NIE-PV-SI.21 Name=Compulsory Elective Master Courser for Specialization Software Engineering, version 2021

NIE-DSS	Decision Support Systems	Z,ZK	5	
The aim of the course	is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principle	s of data-oriented	, model-oriented	
and knowledge-oriented	ed decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They	will also learn ab	out the principles	
of conceptually and or	ntologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithm	ns.		
NIE-MEP	Modelling of Enterprise Processes	Z,ZK	5	
The subject is focused	i on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approa	, ch for (re)enginee	ring and	
implementation of pro	cesses, organisation structures and information support in big enterprises and institutions.			
NIE-TSW	Software Product Development	KZ	4	
The course aims to ac	quaint students with the tools and procedures of project management in the ICT environment. By completing the course, studer	ts will master the	various methods	
and techniques of pro	ject management and apply them in practice. Students will get acquainted with the issue of creating an IT product, ie. preparat	tion of business m	odel, creation of	
financial model and creation of project schedule including basic design of architecture and appearance of the given IT product. At the same time, they will try to present the prepared				
parts of the project to a jury composed of experts from practice. // This course is a continuation of the bachelor's course Project Management.				

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

Code of the group: NIE-SI-VS.21 Name of the group: Elective Vocational Courses for Master Specialisation Software Engineering Requirement credits in the group: Requirement courses in the group: Credits in the group: 0

Note on the group:

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

Note on the group				eption 0	i una apeci	anzation
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-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MVI	Computational Intelligence Methods Miroslav epek, Pavel Kordík Pavel Kordík (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 Rodrigo Augusto Da Silva Alves Rodrigo Augusto Da Silva Alves Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	v
NIE-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-DSV	Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BVS	Embedded Security Ji í Bu ek, Martin Novotný Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	v
NIE-HWB	Hardware Security Ji í Bu ek Ji í Bu ek Ji í Bu ek (Gar.)	Z,ZK	5	2P+2C	L	v
NIE-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz, Olha Jure ková Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	v
NIE-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	v
NIE-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-SIB	Network Security Tomáš Zahradnický, Ji í Dostál, Simona Forn sek, Gramoz Cubreli Simona Forn sek 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,L	V
NIE-OSY	Operating Systems and Systems Programming Petr Zemánek Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	v
NIE-SBF	System Security and Forensics Tomáš Zahradnický, Ji í Bu ek, Simona Forn sek, Marián Svetlík Simona Forn sek Simona Forn sek (Gar.)	Z,ZK	5	2P+1C	Z	v
NIE-TES	Systems Theory Tomáš Kolárik, Stefan Ratschan, Ji í Vysko il Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-TSP	Testing and Reliability Petr Fišer Petr Fišer Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NIE-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V

Characteristics of the courses of this group of Study Plan: Code=NIE-SI-VS.21 Name=Elective Vocational Courses for Master Specialisation Software Engineering

NIE-KRY	Advanced Cryptology	Z,ZK	5			
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of						
random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of						
their own systems or to the creation of their own software solutions.						
NIE-AIB	Algorithms of Information Security	Z,ZK	5			
Students will get acquai	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, st	udents will learn t	he mathematical			
principles of cryptograp	hic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware dete	ction and the use	of machine			
learning in detection sy	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.					
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. Stud	ents will learn how	w these methods			
work and how to apply	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 n	nethods being			
used in practice. The ov	erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, si	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 students should know machine learning						
basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel						
methods).	methods).					

NIE-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
	acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level	1 '	and with the
properties of proper to	ols. The course covers today recent verification methods, too.		
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
Students are introduced	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of compu	iting processes and	d communication
channels. They learn b	asic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms the	hat support high av	vailability of both
	safety in case of failures.		
NIE-EPC	Effective C++ programming	Z,ZK	5
	use the modern features of contemporary versions of the C++ programming language for software development. The course f		mming effectivity
and efficiency in the fo	rm of writing maintainable and portable source code and creating correct programs with low memory and processor time require		
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
, ° °	e of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both ac	ccess time and me	mory complexity.
	e the knowledge in design of applications that utilize pattern matching.		
NIE-EHW	Embedded Hardware	Z,ZK	5
-	c laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is t		
	n their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discuss	sed, including stan	dardized means
	ion, parallelism extraction and utilization in special structures and system architectures.		
NIE-BVS	Embedded Security	Z,ZK	5
	owledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of c		
	Ided systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resou	irces for securing i	nternal functions
of computer systems.		7 71/	
NIE-ESW	Embedded Software	Z,ZK	5
	urse acquainted students with the specifics of software development for embedded systems. The course covers the areas from the		
combined with artificial	e optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing	, up to sophisticate	ea techniques
NIE-BKO		7 71/	F
	Error Control Codes	Z,ZK	5
	e basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary ma I codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to impl		
-	types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channel		
			5
NIE-GPU Students will gain know	GPU Architectures and Programming vledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the		-
-	spread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical		-
	tion programming techniques and methods of programming multiprocessor GPU systems.	computational stru	iciales, stadents
NIE-GAK	Graph theory and combinatorics	Z,ZK	5
	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith	1 '	-
-	sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected	-	-
-	ry, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The thec		
	ords, formal languages and bioinformatics.	,	
NIE-HWB	Hardware Security	Z,ZK	5
	e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu	1 1	-
	. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stu	-	-
the cryptographic acce	lerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the c	omputer.	
NIE-MKY	Mathematics for Cryptology	Z,ZK	5
Students will gain deep	ber knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.		course focuses
on the problem of solvi	ng a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of disc	rete logarithm. The	e problem of
factorization will also b	e solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NIE-MTI	Modern Internet Technologies	Z,ZK	5
Students learn advanc	ed networking technologies and protocols for both local area networks and wide area networks. They get acquainted with rou	iting techniques ar	nd transfer
technologies of moder	n 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 acqua	inted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or	n multicore proces	sors with shared
-	emory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of a		-
-	uce the decrease in computing power due to the widening performance gap between the computational requirements of multi	i-core CPUs and m	nemory interface
	c non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.	1	
NIE-SIB	Network Security	Z,ZK	5
-	theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a		
	pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network t		
· · ·	cal examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general	principals of hand	ling detected
	ident handling and incident response).	7 71/	-
NIE-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
	iced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such me element method and the finite difference method used for solving ordinary and partial differential equations in engineering. T		
	ons that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement		
as well as in parallel.		sin these algorithm	is sequentially
NIE-OSY	Operating Systems and Systems Programming	Z,ZK	5
	on the design and implementation of the basic components that make up modern operating systems. This includes threads, p	1 2 1	
	interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system arc		-
	hin the course, they will gain practical experience with the development of a small but fully functional operating system.		
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 '	
	ntroduced to special applications of parsers, such as incremental and parallel parsing.		

NIE-REV	Reverse Engineering	Z,ZK	5			
	amentals of reverse engineering of computer software (methods of executing and initializing programs, organization of execu	itable files, work v	vith third-party			
libraries). Special attent	libraries). Special attention will be paid to C ++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation methods. Finally, the course					
will focus on code comp	pression and decompression and executable file reconstruction.					
NIE-SBF	System Security and Forensics	Z,ZK	5			
Students will be introdu	ced to various aspects of system security (principles of endpoint security, principles of security policies, security models, auth	entication concep	ts). Students will			
also learn about forensi	c analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis	techniques, and	the importance			
of memory or file syster	n artifacts for attack analysis and detection).					
NIE-TES	Systems Theory	Z,ZK	5			
Today, humankind has t	he ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However	er, the costs of m	anaging this			
complexity and of ensur	ring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage c	of models that des	cribe only those			
aspects of the systems	that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and	algorithms that fo	rm the basis for			
the modeling and analy	sis of complex systems.					
NIE-TSP	Testing and Reliability	Z,ZK	5			
Students will gain know	ledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to p	prepare a test set	with the help of			
the intuitive path sensiti	zation 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 know	ledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	d organizations. T	hey will get			
acquainted with virtualized	zation principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to effi	iciently operate a	nd optimize the			
performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the						
management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration						
and development tools	(Continuous integration and development).					
Code of the ar	oup: NIF-V 21					

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:

note on the gro	up.					
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 Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-MVI	Computational Intelligence Methods Miroslav epek, Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NIE-SCE1	Computer Engineering Seminar Master I Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	Z	V
NIE-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná Denisa Nová ková Denisa Nová ková (Gar.)	Z	2	4C	Z,L	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 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-OSY	Operating Systems and Systems Programming	Z,ZK	5	2P+1C	Z	v
NIE-PAM	Petr Zemánek Petr Zemánek Petr Zemánek (Gar.) Parameterized Algorithms	Z,ZK	4	2P+1C	L	v
	Ond ej Suchý Ond ej Suchý Ond ej Suchý (Gar.) Parsing and Compilers					
NIE-SYP	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
FIT-ACM1	Programming Practices 1 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM2	Programming Practices 2 Ond ej Suchý	KZ	5	4C	Z	V
FIT-ACM3	Programming Practices 3 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM4	Programming Practices 4 Ond ej Suchý	KZ	5	4C	Z	V
FIT-ACM5	Programming Practices 5 Ond ej Suchý	KZ	5	4C	L	V
FIT-ACM6	Programming Practices 6 Ond ej Suchý	KZ	5	4C	L	V
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 (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-SEP	World Economy and Business	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	courses of this group of Study Plan: Code=NIE-V.21 Name=Pu	relv elective	master'	s courses	5	1
NIE-MVI Co Students will understand the to solving a wide range of pro work and how to apply them NIE-EVY	mputational Intelligence Methods basic methods and techniques of computational intelligence, which are based on tradi- oblems. The subject is also devoted to modern neural networks and the ways in which th to problems related to data extraction, management, intelligence in games and optimis icient Text Pattern Matching	tional artificial int ey learn and neu sation, etc.	elligence, a roevolution	Z are parallel in Students wil	,ZK nature and I learn how t	hese methods
	ficient algorithms for text pattern matching. They learn to use so called succinct data stru knowledge in design of applications that utilize pattern matching.	ictures that are ef	ficient in bo	th access tim	e and memo	ory complexity.
This course is focused on the memory, system calls, interru	erating Systems and Systems Programming e design and implementation of the basic components that make up modern operating s upts and interactions of SW and HW using drivers. Students will learn the theory of the	concept of opera	ating syster	ds, processes		
	e course, they will gain practical experience with the development of a small but fully furst rsing and Compilers	anctional operatin	ig system.	Z	,ZK	5
The module builds upon the k	nowledge of fundamentals of automata theory, formal language and formal translation th	eories. Students (gain knowle		·	-
	uced to special applications of parsers, such as incremental and parallel parsing.			Z	,ZK	5
code and deploy a secure de relationship between blockch	foundations of blockchain technology, smart contract programming, and gain an overvie ecentralized application, and assess whether integration of a blockchain is suitable for a nains and information security. It is concluded with a defense of a research or applied s	a given problem.	The course	places an in	creased emp	phasis on the
NIE-CPX Co	of blockchain-based solutions in both academia and business. mplexity Theory fundamental classes of problems in the complexity theory and different models of class	vitme and about	implication		,ZK	5 practical
(in)tractability of difficult prob	fundamental classes of problems in the complexity theory and different models of algo lems.	mins and about	inplication:		y concernin	y practical
	mputability functions and effective computability.			Z	,ZK	4
NIE-ARI Co	mputer arithmetic ata representations used in digital devices and will be able to design arithmetic operation	ons implementati	on units	Z	"ZK	4
		pierionau				

NIE-SCE1	Computer Engineering Seminar Master I	Z	4		
	ter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	ce to failures and a	attacks. Students		
are approached individ	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	the subject is wor	k with scientific		
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each					
semester.					
NIE-SCE2	Computer Engineering Seminar Master II	Z	4		
	ter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance with the selected as a second state of the selected as a second se				
	ually 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.		chers. The topics a	are new ior each		
NI-DSW	Design Sprint	7	2		
	peesion oprime rojects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to va				
	will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting v				
testing the prototypes (plus final presentation).		-		
NI-DID	Digital drawing	Z	2		
The course will introduc	e students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p	erspective and co	lor theory, which		
	y in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The cou	-	e who wants to		
	g and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice ga	-			
NI-GLR	Games and reinforcement learning	Z,ZK	4		
	ent learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intellig	gence. This course	e is intended to		
• ,	al and practical background so you can participate in related research activities. Presented in English.				
NI-GRI	Grid Computing	Z,ZK	5		
	n knowledge about the world-wide network and computing infrastructure.				
NIE-HMI	History of Mathematics and Informatics	Z,ZK	3		
	selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer	-			
	is between computer science and mathematical methods. Some examples of applications of mathematics to computer scien				
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5		
	troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar	with the most func	lamental notions		
	be able to solve simple algorithmic problems with a geometric component.				
FITE-EHD	Introduction to European Economic History	Z,ZK	3		
	a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global e				
	story. As European countries have been dominant actors in this process it focuses predominantly on their roles in the econom to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial insi		•		
	economic history of particular European countries but rather the impact of trade and role of particular events, institutions and	-			
	a mixture of lecture and discussion.	a organizations in	nistory. Oldss		
MIE-MZI	Mathematics for data science	Z,ZK	4		
	ents are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used i	· · ·	-		
	gebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality prir				
1	robability theory and statistics.	1 / 0	,		
NIE-AM2	Middleware Architectures 2	Z,ZK	5		
	trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architec	· · ·	-		
for microservices, distru	ibuted cache and databases, smart contracts, realtime communication and web security.		-		
NIE-PAM	Parameterized Algorithms	Z,ZK	4		
	ation problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often nece		se problems		
exactly in practice. We	will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	one can find a cor	mmon 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		
	input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomia				
	the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solut				
	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		
	e relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.	7 71			
NIE-ROZ	Pattern Recognition	Z,ZK	5		
	is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the s ill learn the fundamental concents and methods of pattern recognition, including probability models, parameter estimation, a		· ·		
NIE-PML	ill learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, an Personalized Machine Learning	Z,ZK	aspects.		
	Personalized Machine Learning earning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteris	1 1	-		
	pommonly used in applications such as recommender systems, which recommend items to users based on their personal inte				
	fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from the				
-	ly, we will focus on cutting-edge models that are of interest to both the research and commercial communities.	soronoui, argoriani	nio, and practical		
NI-AML	Advanced machine learning	Z,ZK	5		
	students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field o	· · ·	-		
	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		
	I 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.					
FIT-ACM1	Programming Practices 1	KZ	5		
	se for preparing talented student for representation in international programming contests.				
FIT-ACM2	Programming Practices 2	KZ	5		
	se for preparing talented student for representation in international programming contests.				
FIT-ACM3	Programming Practices 3	KZ	5		
	se for preparing talented student for representation in international programming contests.	· · ·			
FIT-ACM4	Programming Practices 4	KZ	5		
This is a selective cours	se for preparing talented student for representation in international programming contests.				

FIT-ACM5	Programming Practices 5	KZ	5		
	e for preparing talented student for representation in international programming contests.				
FIT-ACM6	Programming Practices 6	KZ	5		
This is a selective cours	e for preparing talented student for representation in international programming contests.				
NIE-VPR	Research Project	Z	5		
1. At the beginning of th	e 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	end of the semes	ter. 2. External		
Master these (MT) supe	ervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for th	e courses BIE-B/	AP, MIE-MPR,		
MIE-DIP). Students, the	n, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the	e 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 he	ad of the departm	ent responsible		
for the topic of the MT. 3	B. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for	the upcoming se	mester should		
aim at fine-tuning the F	T 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	he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to	echnologies, meth	ods and best		
practices for modelling,	integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg	e graphs and the	r systematic		
quality assurance.					
MI-SCE1	Computer Engineering Seminar Master I	Z	4		
The Seminar of Comput	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistand	e to failures and a	attacks. Students		
are approached individu	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of t	he subject is wor	k with scientific		
articles and other profes	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tead	chers. The topics	are new for each		
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 and	cks. Students get	familiar with		
various kinds of side ch	annels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks ar	d get familiar with	ו higher-order		
attacks. They also get p	ractice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel inform	ation leakage.			
NIE-DDW	Web Data Mining	Z,ZK	5		
Students will learn lates	t methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain	an overview of W	/eb mining		
techniques for Web craw	rling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an over	rview of most rece	nt developments		
in the field of social web	and recommendation systems.				
NIE-BPS	Wireless Computer Networks	Z,ZK	4		
Students will learn abou	t the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in	ad-hoc networks,	multicast and		
broadcast mechanisms	and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get know	wledge of security	/ mechanisms		
for wireless networks ar	nd get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.				
NIE-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 and	d key regions of w	orld economy.		
Students get to know at	bout different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedor	n, corruption and	economic		
development, which are	needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on in	idividual readings	. It is advised to		
take bachelor level of th	is course BIE-SEP as a prerequisite.				
FITE-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 and	d key regions of w	orld economy.		
Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic					
development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to					
take bachelor level of th	is course BIE-SEP as a prerequisite.				
		,	,		

List of courses of this pass:

Code	Name of the course	Completion	Credits
FIT-ACM1	Programming Practices 1	KZ	5
1	This is a selective course for preparing talented student for representation in international programming contests.	1	1
FIT-ACM2	Programming Practices 2	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.	1	1
FIT-ACM3	Programming Practices 3	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.	1	
FIT-ACM4	Programming Practices 4	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.	1	•
FIT-ACM5	Programming Practices 5	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM6	Programming Practices 6	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		•
FITE-EHD	Introduction to European Economic History	Z,ZK	3
The course introduce	s a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global ec	onomy through the	description
of the key periods in I	history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic	history. From large	e economic
area of Roman Empire	e to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institu	tions is deciphered	. The course
does not cover detail	ed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and	organizations in his	story. Class
	meetings will consist of a mixture of lecture and discussion.		

FITE-SEP	World Economy and Business	Z,ZK	4
	uces students of technical university to the international business. It does that predominantly by comparing individual countries and k	, ,	
-	know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedor	-	
development, whic	ch are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv	ridual 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		
	idividually 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.	rs. The topics are n	iew for each
		771	4
MIE-MZI	Mathematics for data science 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		-
mendee mainly.	selected notions from probability theory and statistics.	spie, gradient met	
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		-
	control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the	-	-
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	7	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	ted prototype in 5 o	
	udents will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with		
	testing the prototypes (plus final presentation).		oning that
NI-GLR	Games and reinforcement learning	Z,ZK	4
	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 Englis		
NI-GRI	Grid Computing	Z,ZK	5
NI-GIXI	Grid computing and gain knowledge about the world-wide network and computing infrastructure.	2,21	5
NIE-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	· · ·	-
	is is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation system)		-
basics. The empha	methods).	terns) and models	(e.g., kerner
NIE-ADP	Architecture and Design patterns	Z,ZK	
			6
The objective of th			5
-	is course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as	well as with unde	rstanding of
the challenges, iss	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 o	well as with under f object-oriented p	rstanding of rogramming
the challenges, iss and get familiar wit	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 o h the commonly used object-oriented design patterns that represent the best practices for solving common software design problems.	well as with under f object-oriented p In the second part t	rstanding of rogramming the students
the challenges, iss and get familiar wit	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 o	well as with under f object-oriented p In the second part t	rstanding of rogramming the students
the challenges, iss and get familiar with will be introduced to	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 o h the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. I o the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems architectures used in large-scale distributed systems.	well as with under f object-oriented p In the second part t , and some advance	rstanding of rogramming the students
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NIE-CPX	Complexity Theory	Z,ZK	5
	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the (in)tractability of difficult problems.	· ·	-
NIE-DDW	Web Data Mining	Z,ZK	5
	rn 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 overview in the field of social web and recommendation systems.	<i>w</i> of most recent de	velopments
NIE-DIP	Diploma Thesis	Z	30
NIE-DSS	Decision Support Systems	Z,ZK	5
The aim of the cour	se is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of	data-oriented, mod	del-oriented
-	ented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods a		e principles
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
	Liced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing	· ·	-
	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.	7 71/	-
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends	to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	the most rundame	ntal notions
NIE-EHW	Embedded Hardware	Z.ZK	5
	basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the	, ,	-
	from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,		
.,	of internal communication, parallelism extraction and utilization in special structures and system architectures.	J	
NIE-EPC	Effective C++ programming	Z,ZK	5
	to use the modern features of contemporary versions of the C++ programming language for software development. The course focus	· ·	g effectivity
and eff	iciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor ti	me requirements.	
NIE-ESW	Embedded Software	Z,ZK	5
Embedded software	e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the ba	sic techniques of pr	ogramming
in C language and	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up combined with artificial intelligence.	to sophisticated to	echniques
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowle	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access	·	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	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some sol	tware tools that all	ow 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.		
-	e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top		
coloring, itallisey i	heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory w of combinatorics on words, formal languages and bioinformatics.	iii be also applied i	
NIE-GPU	GPU Architectures and Programming	Z,ZK	5
	nowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI	· ·	
-	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
The course focuse	es on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer sci	ence The topics ar	e selected
for finding s	ome relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science	iences will be show	wed.
NIE-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
	dicated 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	-	-
	hey also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel		
NIE-HWB	Hardware Security as the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards	Z,ZK	5 the system
	eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student	-	
	ptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions	•	age about
NIE-KOD	Data Compression	Z,ZK	5
	duced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data		
	ne 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.		
NIE-KOP	Combinatorial Optimization	Z,ZK	6
The students will g	pain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only	/ to select and imp	lement but
NIE-KRY	also to apply and evaluate heuristics for practical problems.	Z,ZK	5
	Advanced Cryptology the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know th	· · ·	
	generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they ca		
	their own systems or to the creation of their own software solutions.		-
NIE-MCC	Multicore CPU Computing	Z,ZK	5
Sudents will get ac	equainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on mu	incore processors	with shared

and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization

techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-complexity throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		ory interface
NIE-MEP Modelling of Enterprise Processes	Z,ZK	5
The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approact	,	-
implementation of processes, organisation structures and information support in big enterprises and institutions.		
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. In provide the security of ciphers is a 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 discret factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on		problem of
NIE-MPI Mathematics for Informatics	Z,ZK	7
The course focuses on selected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-variate	,	1
and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The	-	-
numerical algorithm and their stability analysis. The topics are completed with the demonstration of applications in computer science. The course focus	es on clear preser	ntation and
argumentation.	_	1
NIE-MPR Master Project	Z	7
1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tas 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 o		
supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/s		
completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic	-	-
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	he FTT will be com	nplete and
approvable at the end of the semester.		
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 routi		d transfer
technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile	-	
NIE-MVI Computational Intelligence Methods Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are parallel	Z,ZK	5
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		
work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation, et		
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 method	s to real-world pro	blems. They
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They		-
linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement to	these algorithms s	equentially
as well as in parallel.	71/	
NIE-NSS Normalized Software Systems Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering.	ZK such as stability f	5
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issue		-
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artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business processes, business rules, processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS. NIE-PMI Personalized Machine Learning 7.7K 5 Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities. Reverse Engineering NIE-REV 7.7K 5 Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of executable files, work with third-party libraries). Special attention will be paid to C++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation methods. Finally, the course will focus on code compression and decompression and executable file reconstruction. 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 statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects. NIE-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, authentication concepts). Students will also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis techniques, and the importance of memory or file system artifacts for attack analysis and detection). NIE-SCE1 Computer Engineering Seminar Master I 7 4 The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in 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-SCE2 Computer Engineering Seminar Master II Ζ Δ The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NIE-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 and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite. NIE-SIB Network Security 7.7K 5 The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically about detection and defense. The course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network traffic. The course focuses on explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general principals of handling detected security events (i.e. incident handling and incident response). NIE-SIM Digital Circuit Simulation and Verification 7.7K 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 Modeling) levels and with the properties of proper tools. The course covers today recent verification methods, too. 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 technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance. 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-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, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems. Testing and Reliability NIE-TSP 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-TSW Software Product Development ΚZ 4 The course aims to acquaint students with the tools and procedures of project management in the ICT environment. By completing the course, students will master the various methods and techniques of project management and apply them in practice. Students will get acquainted with the issue of creating an IT product, ie. preparation of business model, creation of financial model and creation of project schedule including basic design of architecture and appearance of the given IT product. At the same time, they will try to present the prepared parts of the project to a jury composed of experts from practice. // This course is a continuation of the bachelor's course Project Management. 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 and organizations. They will get

acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development).

 NIE-VPR
 Research Project
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 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 course 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 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	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 probab	ility theory; Multivariate normal distribution; Entropy and its application to coding; Statistical tests: T-tests, goodness of fit tests, independ	dence test; Randor	n 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 2025-07-27, time 19:25.