Study plan

Name of study plan: Master specialization Computer Science, in English, 2024

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: 97

Elective courses credits: 23 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 2024/2025. . 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 (Gar.)	Z,ZK	6	2P+2C	L	PP
NIE-VSM	Selected statistical Methods Petr Novák Pavel Hrabák Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

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

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

1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. The external supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/student/studijni/formulare). The completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.

NIE-MPI Mathematics for Informatics Z,ZK 7

The course focuses on selected topics from general algebra with emphasis on finite structures used in computer science. It includes topics from multi-variate analysis, smooth optimization, and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic includes selected numerical algorithm and their stability analysis. The topics are completed with the demonstration of applications in computer science. The course focuses on clear presentation and argumentation.

NIE-PDP Parallel and Distributed Programming

Z.ZK

6

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

NIE-VSM Selected statistical Methods

Z,ZK

7

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

Name of the block: Compulsory courses in the specialization

Minimal number of credits of the block: 34

The role of the block: PS

Code of the group: NIE-TI-PS.24

Name of the group: Mgr. Specialization Computer Science, Version 2024 Requirement credits in the group: In this group you have to gain 34 credits

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

Credits in the group: 34

Note on the group:

Note on the gi	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-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	3P+1C	Z	PS
NIE-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-EVY	Efficient Text Pattern Matching 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-LOM	Linear Optimization and Methods Dušan Knop Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+0S+1C	Z	PS
NIE-PAM	Parameterized Algorithms Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	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.24 Name=Mgr. Specialization Computer Science, Version 2024

NIE-CPX	Complexity Theory	Z,ZK	5
Students will learn abou	t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	ne theory concern	ing practical
(in)tractability of difficult	problems.		
NIE-KOD	Data Compression	Z,ZK	5
Students are introduced	i to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of da	ita 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-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 mer	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 theor	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-LOM	Linear Optimization and Methods	Z,ZK	5

Students will gain an overview of applications of optimization methods in computer science, economics and industrial practice. They will be introduced to the practical importance of linear and integer programming. They will be able to work with optimization software and to master the languages used in its programming. They will be able to formalise optimisation problems in the areas of computer science (e.g. task allocation to processors, network flow analysis), resource distribution and allocation (traffic problems, business traveller problem, etc.). Gain an overview of computational complexity issues in optimization. Gain a good understanding of linear programming algorithms and selected integer linear programming algorithms.

NIE-PAM Parameterized Algorithms

Z,ZK

4

There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.

NIE-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 Kohlík Martin Kohlík Martin Kohlík (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 Daniel Langr Daniel Langr 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 (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 Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	VO
NIE-HWB	Hardware Security Ji í Bu ek Ji í 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 Ji í Dostál (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
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

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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 (Gar.)	Z,ZK	5	2P+2C	Z	VO
NIE-NUR	User Interface Design 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
Computer Science	e courses of this group of Study Plan: Code=NIE-TI-VS.21 Name=	Elective Vocat	ional Co	urses for N	laster Sp	ecializatio
	dvanced Cryptology				,ZK	5
	entials of cryptanalysis and the mathematical principles of constructing symmetric and					
random number generator	s. They will have an overview of cryptanalysis methods, elliptic curve cryptography and	quantum cryptogi	aphy, whic	h they can app	oly to the inte	egration of
their own systems or to the	e creation of their own software solutions.					
NIE-PDB A	Advanced Database Systems			Z	,ZK	5
Students orient themselves	s in problems of evaluation and optimization of SQL queries. The next part of the cours	e deals with new o	concepts of	database ma	chines (so c	alled NoSQL
databases), with the relate	ed new data models (XML, graph databases, column databases) and languages for wor	king with them (X	Query, XPa	th, CYPHER,	Gremlin). Th	ne last part of
the course deals with perfo	ormance evaluation of database machines. This course is equivalent to the course MIE	PDB.				
NIE-PIS A	Advanced Information Systems			Z	,ZK	5
Students learn the notion of	of business process logic and its formalization, with business process roles, business rul	es, and data proce	essing, with	the notion of	service orier	nted compan
enterprise services and se	ervice solution of business logic. They get acquainted with these notions also for the oth	er types of ISs. Th	ney learn al	bout agility and	d adaptivity a	and using of
artificial intelligence metho	ods for implementation of these ideas in ISs. They understand modern object-oriented r	nethodologies for	modelling o	of business pro	cesses, bus	siness rules,
processed data, and enter	prise ISs. They will get the rules and technologies for successful implementation of IS.					
NIE-AIB A	Algorithms of Information Security			Z	,ZK	5
	ed with the algorithms of secure key generation and cryptographic error (not only biometr	ic) data processing	g. Furtherm			mathematic
principles of cryptographic	protocols (identification, authentication, and signature schemes). Another part of the c	ourse is dedicated	l to malwar	e detection an	d the use of	machine
	ms. The last topic includes practical steganographic methods and attacks on steganographic					
	Pata Mining Algorithms			7	,ZK	5
	porithms used in the fields of machine learning and data mining. However, this is not an	introductory cours	se and the			-
	ut on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine lea					
methods).	3, 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	3 (- 3 ,			,	- (- 3 / -
· · · · · · · · · · · · · · · · · · ·	Architecture and Design patterns			7	,ZK	5
	e is to provide students with both work knowledge about the underlying foundations of	object-oriented de	cian and a			-
<u>-</u>	d tradeoffs of advanced software design. In the first part of the course, the students will	-	-	=		_
	mmonly used object-oriented design patterns that represent the best practices for solvir					
	inciples of software architecture design and analysis. This includes the classical architec					
·	e-scale distributed systems.			,		
, i	Digital Circuit Simulation and Verification			7	,ZK	5
l l	quaint the students with principles of digital circuit simulation at RTL (Register Transfer I	evel) and TLM (Ti	ransaction	I I	·	
· ·	The course covers today recent verification methods, too.	Level) and TEIVI (II	ansaction	Level Modelling	J) levels and	i with the
	<u> </u>				71/	
	Distributed Systems and Computing				,ZK	5
	methods for coordination of processes in distributed environment characterised by nonder		-			
•	c algorithms that assure correctness of computations realized by a group of loosely cou	pied processes an	a mecnani	sms tnat supp	ort nign avai	lability of bo
data and services, and saf	•					
	ffective C++ programming				,ZK	5
	the modern features of contemporary versions of the C++ programming language for s					ning effectivit
	of writing maintainable and portable source code and creating correct programs with lo	w memory and pro	cessor tim			
NIE-EHW E	mbedded Hardware			Z	,ZK	5
_	lws that govern digital design and basic techniques to use them. It deals with both large		-			
systems, that profit from th	neir specialized structure for effective computation and acceleration. Design of fast cust	om computing ma	chines is di	iscussed, inclu	ıding standa	rdized mear
of internal communication,	, parallelism extraction and utilization in special structures and system architectures.					
NIE-BVS E	Embedded Security			Z	,ZK	5
· ·	edge in selected topics of cryptography and cryptanalysis. The course focuses particular	ly on efficient impl	ementation			_
-	d systems). Students gain a good overview of functionality of (hardware) cryptographic a	-			-	
of computer systems.		,	•		•	
	Embedded Software			7	,ZK	5
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Embedded Software NIE-ESW

Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence.

NIE-BKO	Error Control Codes	Z,ZK	5
•	e basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mat	=	
	codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to imple		ctions and
	types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channel		
NIE-FME	Formal Methods and Specifications scribe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some	Z,ZK	5
basic properties of soft	·	e software tools til	at allow to prove
NIE-GPU	GPU Architectures and Programming	Z,ZK	5
	ledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the	. , ,	_
_	pread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical of		-
•	ion programming techniques and methods of programming multiprocessor GPU systems.	,	,
NIE-HWB	Hardware Security	Z,ZK	5
The course provides the	e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegua	ards against abus	e of the system
using hardware means.	They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stud	dents will gain kno	wledge about
the cryptographic accel	erators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the co	omputer.	
NIE-MKY	Mathematics for Cryptology	Z,ZK	5
	er knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.	-	
•	ng a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discre	ete logarithm. The	problem of
	solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NI-MVI	Computational Intelligence Methods	Z,ZK	. 5
	d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to	many problems. T	ney will learn
	k and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.	771/	
NIE-AM1	Middleware Architectures 1	Z,ZK	5 wob sorvice
-	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information sys on servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co		
•	on servers. The will also study principles and technologies for middleware locused on application integrations, asynchronous co irse replaces the course MIE-MDW.	ammumbanons afic	a riigi i avaliabilily
NIE-MTI	Modern Internet Technologies	Z,ZK	5
	Modern Internet Technologies Id networking technologies and protocols for both local area networks and wide area networks. They get acquainted with rout		
	internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.	ang teeninques ar	ia transier
NIE-MCC	Multicore CPU Computing	Z,ZK	5
	nted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on		-
	mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of ar	· · · · · · · · · · · · · · · · · · ·	
· ·	ice the decrease in computing power due to the widening performance gap between the computational requirements of multi-		-
throughput. On specific	non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introdu	ced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such met	' '	
		thods to real-world	l problems. They
will also learn the finite	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The		
linear algebraic equatio		hey will learn to so	olve systems of
linear algebraic equation as well as in parallel.	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The state are from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme	hey will learn to so nt these algorithm	olve systems of is sequentially
linear algebraic equation as well as in parallel. NIE-SIB	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The strategy of the continuous problems by direct and iterative algorithms. They will also learn to impleme Network Security	hey will learn to so nt these algorithm Z,ZK	blve systems of as sequentially
linear algebraic equation as well as in parallel. NIE-SIB The students will gain to	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The substitution of the continuous problems by direct and iterative algorithms. They will also learn to impleme Network Security neoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a	hey will learn to so nt these algorithm Z,ZK bout detection an	olve systems of as sequentially 5 d defense. The
linear algebraic equation as well as in parallel. NIE-SIB The students will gain to course explains basic parallel.	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The stat arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme Network Security Network Security neoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a ricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network tr	hey will learn to so nt these algorithm Z,ZK bout detection and raffic. The course for	blve systems of as sequentially 5 d defense. The ocuses on
linear algebraic equation as well as in parallel. NIE-SIB The students will gain to course explains basic pexplanation and practice.	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The stat arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme Network Security Network Security neoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a ricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network tradexamples of various mechanisms of securing network infrastructure and detection in real time. The course covers general page 1.	hey will learn to so nt these algorithm Z,ZK bout detection and raffic. The course for	blve systems of as sequentially 5 d defense. The ocuses on
linear algebraic equation as well as in parallel. NIE-SIB The students will gain to the course explains basic perpendicular explanation and practice security events (i.e. incident).	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The stat arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme the Network Security Network Security neoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a ricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network to all examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general ident handling and incident response).	hey will learn to so nt these algorithm Z,ZK bout detection and affic. The course to principals of hand	5 d defense. The occuses on ling detected
linear algebraic equation as well as in parallel. NIE-SIB The students will gain to course explains basic pexplanation and practice security events (i.e. incitation).	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The stat arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme the Network Security Network Security neoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a ricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network trail examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general dent handling and incident response). Normalized Software Systems	hey will learn to so nt these algorithm Z,ZK bout detection and raffic. The course to principals of hand	5 d defense. The ocuses on ling detected
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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).

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-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 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-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 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 (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 (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

NUE OVA/E	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 (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 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	courses of this group of Study Plan: Code=NIE-V.21 Name=Pu	rely elective	master's	s courses	1	
	omplexity Theory	,			ZK	5
Students will learn about the	e fundamental classes of problems in the complexity theory and different models of algo	oritms and about	implications	of the theory	, concernin	g practical
(in)tractability of difficult prob	olems.					
NIE-EVY Eff	ficient Text Pattern Matching			Z	ZK	5
Students get knowledge of e	fficient algorithms for text pattern matching. They learn to use so called succinct data stru	uctures that are e	ficient in bo	th access tim	e and memo	ory complexity.
They will be able to use the	knowledge in design of applications that utilize pattern matching.					
NIE-PAM Pa	rameterized Algorithms			Z.	ZK	4
There are many optimization	n problems for which no polynomial time algorithms are known (e.g. NP-complete proble	ems). Despite tha	at it is often	necessary to	solve these	problems
exactly in practice. We will d	emonstrate that many problems can be solved much more effectively than by naively try	ving all possible	solutions. O	ften one can	find a comn	non property
	m practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that b					
. , .	t size (which can be huge). Parameterized algorithms also represent a way to formalize				•	, ·
	classical complexity. Such a polynomial time preprocessing is then a suitable first step,					
•	Igorithm design methods and we will also show how to prove that for some problem (an		-			
			_	**	ibiy) does n	ot exist. We
	ations to other approaches to hard problems such as moderately exponential algorithms	s or approximation	on schemes			
NIE-SYP Pa	rsing and Compilers			Z	ZK	5
The module builds upon the I	knowledge of fundamentals of automata theory, formal language and formal translation the	eories. Students	gain knowle	dge of various	s variants ar	nd applications
of LR parsing and are introd	uced to special applications of parsers, such as incremental and parallel parsing.					
NIE-BLO BIO	ockchain			7	ZK	5
	foundations of blockchain technology, smart contract programming, and gain an overvie	aw of most notab	e blockchair			-
	ecentralized application, and assess whether integration of a blockchain is suitable for a	0 1		•		
	hains and information security. It is concluded with a defense of a research or applied so	emester project,	which prepa	ares the stud	ents for imp	lementing or
	of blockchain-based solutions in both academia and business.					
NIE-VYC Co	omputability			Z	ZK	4
01	functions and effective computability				'	_
classical theory of recursive	runctions and effective computability.				'	7
				Z	<u>'</u>	5
NIE-MVI Co	omputational Intelligence Methods	itional artificial in	telligence, a		ZK	5
NIE-MVI Co Students will understand the	omputational Intelligence Methods e basic methods and techniques of computational intelligence, which are based on tradi		_	re parallel in	ZK nature and	5 are applicable
NIE-MVI Co Students will understand the to solving a wide range of pro	omputational Intelligence Methods be basic methods and techniques of computational intelligence, which are based on tradi collems. The subject is also devoted to modern neural networks and the ways in which the	ey learn and neu	_	re parallel in	ZK nature and	5 are applicable
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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 w	rith the most funda	mental notions
of this discipline, and to be able to solve simple algorithmic problems with a geometric component.		
FITE-EHD Introduction to European Economic History	Z,ZK	3
The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economic history.	conomy through th	ne description
of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economi	c history. From lar	ge economic
area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institution	tutions is deciphe	red. The course
does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and	organizations in h	nistory. Class
meetings will consist of a mixture of lecture and discussion.		
MIE-MZI Mathematics for data science	Z,ZK	4
In this course, the students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in		-
include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle)		-
selected notions from probability theory and statistics.	sipio, gradioni moi	nodo) una
	7 71/	
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 architect	ures, concepts an	d technologies
for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.		
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 st	atistical approach	to pattern
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and	d their numerical a	aspects.
NIE-PML Personalized Machine Learning	Z,ZK	5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristic	ics and behaviors	
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal inter-		
to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from the	oretical, algorithm	ic, and practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.	,	.,
NI-AML Advanced machine learning	Z,ZK	5
The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of		-
processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the r		
NIE-PDL Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning using pyTorch, and a popular open-source machine learning using pyTorch, and a popular open-source machine learning using pyTorch, a popular open-source machine learning using pyTorch, and a pyTorch with a pyTorc	_	- 1
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields suc	ch as computer vis	ion and natural
language processing.		
NIE-VPR Research Project	Z	5
1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on 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 semest	er. 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	e courses BIE-BAI	P, MIE-MPR,
MIC DID. Children the annual that the annual transfer of the information protein (IC) has a big internal ET annual that the information protein (IC) has a big internal ET annual that the information protein (IC) has a big internal ET annual that the information protein (IC) has a big internal ET annual that the information protein (IC) has a big internal ET annual that the information protein (IC) has a big internal ET annual that the information protein (IC) has a big internal ET annual that the information (IC) has a big internal ET annual that the info		no IS based on
MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the	e assessment to tr	ie io baseu 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 heat		
	ad of the departme	ent responsible
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 heaf 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	ad of the departme	ent responsible
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 heaf for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.	ad of the departme the upcoming ser	ent responsible nester should
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List of courses of this pass:

Code	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		
	in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic		
-	pire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial instituti	· ·	
does not cover de	tailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and c meetings will consist of a mixture of lecture and discussion.	rganizations in his	tory. Class
FITE-SEP	World Economy and Business	Z,ZK	4
ı	uces students of technical university to the international business. It does that predominantly by comparing individual countries and k		economy.
Students get to I	know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedon	n, corruption and e	conomic
development, which	h are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on indiv	idual readings. It is	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		
	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the		
articles and other p	rofessional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester.	s. The topics are n	ew ior eac
MIE-MZI	Mathematics for data science	Z.ZK	4
	students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in date	,	udied topic
	near algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ		
	selected notions from probability theory and statistics.		
NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses	s on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students	should know mach	ine learnin
basics. The emphas	sis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation syst	ems) and models	(e.g., kerne
	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	-	_
	control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with t		
NI-DID	Digital drawing	Z	2
The course will intro			
	oduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, persp		-
they will practically	apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course	is fit for anyone wh	no wants to
they will practically practice or	apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practic	is fit for anyone wh	no wants to ge.
they will practically practice or NI-DSW	apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice. Design Sprint	is fit for anyone whoe gained knowled	no wants to ge.
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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 t	technologie
	for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.		1
NIE-ARI	Computer arithmetic	Z,ZK	4
NIE DKO	Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementat		
NIE-BKO	Error Control Codes	Z,ZK	5
· ·	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 telecommunical		
NIE-BLO	Blockchain	Z,ZK	5
	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platform	•	•
	secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places a en blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the	-	
ciationship betwe	supervising implementation of blockchain-based solutions in both academia and business.	Students for impr	cincilling c
NIE-BPS	Wireless Computer Networks	Z,ZK	4
Students will lear	n about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-		ulticast and
broadcast mecha	nisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowle	-	nechanism
NIE DVO	for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitab		
NIE-BVS	Embedded Security c knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of crypto	Z,ZK	5 Sin hardwa
ŭ	bedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources	•	
	of computer systems.		
NIE-CPX	Complexity Theory	Z,ZK	5
Students will lea	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	theory concerning	g practical
NIE DOW	(in)tractability of difficult problems.	7 71/	
NIE-DDW Students will les	Web Data Mining arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain a	Z,ZK	5 eb mining
	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.		
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		
hannels. They lea	rn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that s	upport high availa	ability of bo
NIE-DVG	data and services, and safety in case of failures. 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		_
	of this discipline, and to be able to solve simple algorithmic problems with a geometric component.		
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		
ystems, that profi	from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, i	including standar	dized meai
NIE-EPC	of internal communication, parallelism extraction and utilization in special structures and system architectures. Effective C++ programming	Z,ZK	5
	the curve C++ programming to use the modern features of contemporary versions of the C++ programming language for software development. The course focus		1
	iciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor ti		-
NIE-ESW	Embedded Software	Z,ZK	5
	e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the base		•
in C language an	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up	to sophisticated	technique
	agent in a divite a stifficial intelligence	· ·	_
NIE EVV	combined with artificial intelligence.		5
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5 v complexi
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	Efficient Text Pattern Matching edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access	Z,ZK	
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NIE-HWB Hardware Security Z,ZK 5 The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer. NIE-KOD **Data Compression** Z,ZK 5 Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data compression methods being used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, students learn the fundamentals of lossy data compression methods used in image, audio, and video compression. NIE-KOP Combinatorial Optimization Z,ZK 6 The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems. Advanced Cryptology Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions. NIE-LOM Linear Optimization and Methods 7.7K 5 Students will gain an overview of applications of optimization methods in computer science, economics and industrial practice. They will be introduced to the practical importance of linear and integer programming. They will be able to work with optimization software and to master the languages used in its programming. They will be able to formalise optimisation problems in the areas of computer science (e.g. task allocation to processors, network flow analysis), resource distribution and allocation (traffic problems, business traveller problem, etc.). Gain an overview of computational complexity issues in optimization. Gain a good understanding of linear programming algorithms and selected integer linear programming algorithms. 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 on multicore processors with shared and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications. **NIE-MKY** Mathematics for Cryptology Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course focuses 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 discrete logarithm. The problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices NIE-MPI Mathematics for Informatics 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. NIF-MPR Master Project 1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. The external supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/student/studijni/formulare). The completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester. NIE-MTI Modern Internet Technologies 5 Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquainted with routing techniques and transfer technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security. NIE-MVI Computational Intelligence Methods Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are parallel in nature and are applicable to solving a wide range of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuroevolution. Students will learn how these methods work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation, etc. NIE-NSS Normalized Software Systems ZK 5 Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures. NIE-NUR User Interface Design 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. Parameterized Algorithms There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes **NIE-PDB** Advanced Database Systems 5 Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PDB.

NIE-PDL Practical Deep Learning ΚZ 5 This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing. NIE-PDP Parallel and Distributed Programming Z,ZK 6 21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Parallel computing systems are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course includes a semester project of practical programming in OpenMP and MPI for solving a particular nontrivial problem. **NIE-PIS Advanced Information Systems** 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 notion of service oriented company, enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about agility and adaptivity and using of artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business processes, business rules, processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS. NIE-PML Personalized Machine Learning Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities. **NIE-REV** Reverse Engineering Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of executable files, work with third-party libraries). Special attention will be paid to C++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation methods. Finally, the course will focus on code compression and decompression and executable file reconstruction. 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 System Security and Forensics 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 Z 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 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 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. Z,ZK **NIE-SIB Network Security** 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 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 The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance. Parsing and Compilers 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 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 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 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	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 tasks that should be carried out					
during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. External					
Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR,					
MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on					
the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of the department responsible					
for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should					
aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.					
NIE-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.					

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