# 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:

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	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	Z,ZK	6	2P+2C	L	PP
NIE-VSM	Selected statistical Methods Pavel Hrabák	Z,ZK	7	4P+2C	L	PP

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

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

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

NIE-MPI Mathematics for Informatics Z,ZK 7

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

### NIE-PDP Parallel and Distributed Programming

,ZK

6

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

NIE-VSM

Selected statistical Methods

Z,ZK

7

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

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 Petra Pavlí ková	Z,ZK	5	2P+1C	L	PS
NIE-ADP	Architecture and Design patterns Ji í Borský, Jan Kurš, Jan Zimolka, Marek B lohoubek Jan Kurš Jan Kurš (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-FME	Formal Methods and Specifications Stefan Ratschan	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 Robert Pergl	ZK	5	2P	L	PS
NIE-NUR	User Interface Design 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

NIE-PDB Advanced Database Systems

Z,ZK

5

Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PDB.

#### NIE-PIS Advanced Information Systems

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-ADP Architecture and Design patterns

Z,ZK

э ..

The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems.

### NIE-FME Formal Methods and Specifications

7.7K

5

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

### NIE-AM1 Middleware Architectures 1

Z,ZK

5

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

NIE-NSS Normalized Software Systems

K

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.

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 (Gar.)	Z,ZK	5	2P+1C	Z	PV
NIE-TSW	Software Product Development 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	l
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	l decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They	will also learn abo	out the principles	
of conceptually and onto	ologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithm	is.		l

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 approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions.

NIE-TSW Software Product Development

K7

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.

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.

140to 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	V
NIE-AIB	Algorithms of Information Security  Martin Jure ek Martin Jure ek Martin Jure ek (Gar.)	Z,ZK	5	2P+1C	Z	V

NIE-MVI	Computational Intelligence Methods  Miroslav epek, Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-KOD	Data Compression  Jan Holub	Z,ZK	5	2P+1C	L	V
NIE-ADM	Data Mining Algorithms Rodrigo Augusto Da Silva Alves	Z,ZK	5	2P+1C	L	V
NIE-SIM	Digital Circuit Simulation and Verification  Martin Kohlik	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 Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BVS	Embedded Security Martin Novotný	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 Kubalik	Z,ZK	5	2P+1C	L	V
NIE-GPU	GPU Architectures and Programming Ivan Šime ek	Z,ZK	5	2P+1C	L	V
NIE-GAK	Graph theory and combinatorics Tomáš Valla	Z,ZK	5	2P+2C	L	V
NIE-HWB	Hardware Security Ji í Bu ek	Z,ZK	5	2P+2C	L	V
NIE-MKY	Mathematics for Cryptology Róbert Lórencz	Z,ZK	5	3P+1C	L	V
NIE-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-SIB	Network Security Simona Forn sek	Z,ZK	5	2P+1C	L	V
NIE-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5	2P+1C	Z,L	V
NIE-OSY	Operating Systems and Systems Programming 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 Fiser Petr Fiser Petr Fiser (Gar.)	Z,ZK	5	2P+2C	Z	V
NIE-VCC	Virtualization and Cloud Computing Tomáš Vondra	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

Advanced Cryptology

NIE-KRY

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

Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical

Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of

Z,ZK

5

principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.

NIE-MVI Computational Intelligence Methods Z,ZK 5
Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are 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-KOD Data Compression

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-ADM	Data Mining Algorithms	Z,ZK	5
	algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the stude		_
basics. The emphasis is methods).	put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation	systems) and mod	dels (e.g., kernel
NIE-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
_	pughtar Gircuit Simulation and verification acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level)		_
	Is. The course covers today recent verification methods, too.	wodeling) ievels a	and with the
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of compu		
channels. They learn ba	sic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms th	nat support high a	vailability of both
data and services, and	safety in case of failures.		
NIE-EPC	Effective C++ programming	Z,ZK	5
	se the modern features of contemporary versions of the C++ programming language for software development. The course for		mming effectivity
	m of writing maintainable and portable source code and creating correct programs with low memory and processor time requ		
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
	of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both ac the knowledge in design of applications that utilize pattern matching.	cess time and mei	mory complexity.
		7 71/	5
NIE-EHW	Embedded Hardware c laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is tl	Z,ZK	_
_	n their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discuss		
	on, parallelism extraction and utilization in special structures and system architectures.	ou, moruumg otam	aa. a.20aoao
NIE-BVS	Embedded Security	Z,ZK	5
_	wledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cr		_
•	ded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resou		
of computer systems.			
NIE-ESW	Embedded Software	Z,ZK	5
	rrse acquainted students with the specifics of software development for embedded systems. The course covers the areas from the		of programming
in C language and code	e optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing,	up to sophisticate	ed 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-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	computational stru	actures, students
	ion programming techniques and methods of programming multiprocessor GPU systems.  Graph theory and combinatorics	7 7K	5
NIE-GAK	Graph theory and combinatorics	Z,ZK	5 s will be not only
NIE-GAK The goal of the class is	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith	ms. The emphasis	s will be not only
NIE-GAK The goal of the class is on undestanding the bar	Graph theory and combinatorics	ms. The emphasis topics from graph	s will be not only and hypergraph
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected	ms. The emphasis topics from graph	s will be not only and hypergraph
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo reds, formal languages and bioinformatics.	ms. The emphasis topics from graph	s will be not only and hypergraph
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo	ms. The emphasis I topics from graph ry will be also app	s will be not only a and hypergraph blied in the fields
NIE-GAK The goal of the class is on undestanding the baccoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo rds, formal languages and bioinformatics.  Hardware Security	ms. The emphasis It topics from graph ry will be also app  Z,ZK  ards against abus	s will be not only and hypergraph blied in the fields  5 e of the system
NIE-GAK The goal of the class is on undestanding the baccoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means.	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo rds, formal languages and bioinformatics.  Hardware Security a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguages.	ms. The emphasis I topics from graph ry will be also app Z,ZK ards against abus dents will gain kno	s will be not only and hypergraph blied in the fields  5 e of the system
NIE-GAK The goal of the class is on undestanding the baccoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means.	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems of the security are knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguathey will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students	ms. The emphasis I topics from graph ry will be also app Z,ZK ards against abus dents will gain kno	s will be not only and hypergraph blied in the fields  5 e of the system
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides thrusing hardware means, the cryptographic accel NIE-MKY Students will gain deep	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems for the security are knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguary will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studentors, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer systems and test them for resistance to attacks. Studentors, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer systems.	ms. The emphasis of topics from graph ry will be also appears against abus dents will gain known puter.  Z,ZK  In particular, the office of the particular and the particular	s will be not only and hypergraph blied in the fields  5 e of the system by blied about  5 course focuses
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solving the class is a class of the class is a class of the class of the class of the class is a class of the class of the class is a class of the class of the class is a class of the class of the class is a class of the class of the class is a class of the class of the class is a close of the class of the class is a close of the class of the class of the class is a close of the class of the	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems for the discrete security and bioinformatics.  Hardware Security They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Sturerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer systems and test them for resistance to attacks. Sturerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer systems and test them for resistance to attacks. Sturerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer system of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete for internal security of ciphers.	ms. The emphasis of topics from graph ry will be also appears against abus dents will gain known puter.  Z,ZK  In particular, the office of the particular and the particular	s will be not only and hypergraph blied in the fields  5 e of the system by blied about  5 course focuses
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems are designed in the security of the security of the security of the analysis and design of computer systems security solutions. Students get an overview of safeguary will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studentors, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. The solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.	ms. The emphasis of topics from graph ry will be also appeared by the second se	s will be not only and hypergraph blied in the fields  5 e of the system between about 5 course focuses a problem of
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security In the combinatorial structures and integrate the problem of computer systems security solutions. Students get an overview of safeguary will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the component of algorithm of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discressive on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies	ms. The emphasis topics from graph ry will be also appropriately will be also appropriately will gain the computer.  Z,ZK  Z,ZK  A rds against abus dents will gain known puter.  Z,ZK  In particular, the content of th	s will be not only and hypergraph blied in the fields  5 e of the system belied about  5 course focuses a problem of
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security In the complete systems security solutions. Students get an overview of safeguary will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the complete system of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. The solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies and protocols for both local area networks and wide area networks. They get acquainted with router of the problem of	ms. The emphasis topics from graph ry will be also appropriately will be also appropriately will gain the computer.  Z,ZK  Z,ZK  A rds against abus dents will gain known puter.  Z,ZK  In particular, the content of th	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretis, formal languages and bioinformatics.  Hardware Security knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguations, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discressived on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies and 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.	ms. The emphasis topics from graph ry will be also approved and seems against abus dents will gain known puter.  Z,ZK In particular, the cete logarithm. The Z,ZK	s will be not only and hypergraph blied in the fields  5 e of the system bwledge about  5 course focuses a problem of  5 dd transfer
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorets, formal languages and bioinformatics.  Hardware Security knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguate the safely use and integrate hardware components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Individual transfer, with various types of network virtualization, and with last-mile security.  Multicore CPU Computing	ms. The emphasis of topics from graph ry will be also appropriate and support of the support of	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 nd transfer
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected by, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretis, formal languages and bioinformatics.  Hardware Security knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguations, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Individual multimedia data transfer, with various types of network virtualization, and with last-mile security.  Multicore CPU Computing  Internet including multimedia data transfer, with various types of network virtualization of parallel multithreaded computations or	ms. The emphasis of topics from graph ry will be also appropriate and support of the support of	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqual and virtually shared me	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security Expensive the analysis and design of computer systems security solutions. Students get an overview of safeguare they will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studentors, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the composition of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. The solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Indicate the most important mathematical problems concerning the security of ciphers. The solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Internet Technologies  Internet 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.  Multicore CPU Computing  Internet Technologies of provided the most common computing nodes of powerful computer systems. Students will gain knowledge of an more mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of an more mory, which are today the most common computing nodes of powerful computer systems.	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of  5 and transfer  5 sors with shared diffic optimization
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduce to solving the solution of the problem of t	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths ic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security Expensive the analysis and design of computer systems security solutions. Students get an overview of safeguations, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computations.  Mathematics for Cryptology  Expensive the most important mathematical problems concerning the security of ciphers. It is a solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Internet Technologies  Internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.  Multicore CPU Computing  Internet indeal with hardware support and programming technologies for the creation of parallel multithreaded computations or mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of all accepted the decrease in computing power due to the widening performance gap between the computational requirements of multice the decrease in computing power due to the widening performance gap between the computational requirements of multice the decrease in computational requirements of multices.	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of  5 and transfer  5 sors with shared diffic optimization
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to redit throughput. On specific	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretics, formal languages and bioinformatics.  Hardware Security a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguent must be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the composition of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discressive on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  In demonstrate 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.  Multicore CPU Computing  Internet Technologies and protocols for both local area networks are networks. Students will gain knowledge of an etworking technologies and protocols for both local area networks of network virtualization, and with last-mile security.  Multicore CPU Computing  Internet 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.  Multicore CPU Computing  Internet Technologies and protocols for both local area networks and wide area networks. They get acquainted with rout internet, in	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 nd transfer  5 sors with shared iffic optimization nemory interface
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to redithroughput. On specific	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths ic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security Expensive the analysis and design of computer systems security solutions. Students get an overview of safeguations, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computations.  Mathematics for Cryptology  Expensive the most important mathematical problems concerning the security of ciphers. It is a solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Internet Technologies  Internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security.  Multicore CPU Computing  Internet indeal with hardware support and programming technologies for the creation of parallel multithreaded computations or mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of all accepted the decrease in computing power due to the widening performance gap between the computational requirements of multice the decrease in computing power due to the widening performance gap between the computational requirements of multice the decrease in computational requirements of multices.	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared offic optimization memory interface
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorets, formal languages and bioinformatics.  Hardware Security a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguenthey will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the composition of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies and 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.  Multicore CPU Computing  Internet Technologies and protocols for both local area networks are networks. Students will gain knowledge of an acceptable in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of an acceptable performance gap between the computational requirements of multinon-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.  Network Security	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of  5 nd transfer  5 sors with shared diffic optimization memory interface  5 d defense. The
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic p	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths ic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theords, formal languages and bioinformatics.  Hardware Security Experimental experimenta	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared offic optimization memory interface  5 d defense. The focuses on
NIE-GAK The goal of the class is on undestanding the bacoloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practice	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theords, formal languages and bioinformatics.  Hardware Security a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguates and will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studentors, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer systems and test them for resistance to attacks. Studentors, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Indicated in detail with hardware and programming technologies for the creation of parallel multithreaded computations or mory, which are today the most common computing nedes of powerful computer systems. Students will gain knowledge of a use the decrease in computing power due to the widening performance gap between the computational requirements of multinon-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.  Network Security  more tical 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 trivial incipal	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared offic optimization nemory interface  5 d defense. The focuses on ling detected
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretics, formal languages and bioinformatics.  Hardware Security  In knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegures will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computation of a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discressored on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  In detworking 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.  Multicore CPU Computing  Inted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or mory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of an inted the decrease in computing power due to the widening performance gap between the computational requirements of multi-non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.  Network Security  In errore to detect anomalies and suspicious network to all examples of various mechanisms of securing network infrastructure and detection in r	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared offic optimization nemory interface  5 d defense. The focuses on ling detected
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introduted.	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguare the safe will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer of a legislation of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. The solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Modernet Technologies  Moderne	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of  5 nd transfer  5 sors with shared diffic optimization memory interface  5 d defense. The focuses on ling detected  5 d problems. They
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introdution will also learn the finite	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorets, formal languages and bioinformatics.  Hardware Security  a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegue. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. They are system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discressive on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Internet Technologi	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared offic optimization nemory interface  5 d defense. The focuses on liling detected  5 d problems. They olve systems of
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introducing algebraic equation.	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguare the safe will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer of a legislation of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. The solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Modernet Technologies  Moderne	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared offic optimization nemory interface  5 d defense. The focuses on liling detected  5 d problems. They olve systems of
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introdution will also learn the finite linear algebraic equation as well as in parallel.	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems of the control of the analysis and design of computer systems security solutions. Students get an overview of safeguar heavily a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguar heavily also also to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students, procedures solving the most important mathematical problems concerning the security functions of the control of the c	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared diffic optimization nemory interface  5 d defense. The focuses on lling detected  5 problems. They olve systems of as sequentially
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solving factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain the course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introduth will also learn the finite linear algebraic equation as well as in parallel. NIE-OSY	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths in troduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems of the combinatorial structures of the combinatorial structures. The theorems of the combinatorial structures are composed for the analysis and design of computer systems security solutions. Students get an overview of safegue hardware Security  In a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegue hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and devices for internal security functions of the combinatorial system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discress of solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  In 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.  Multicore CPU Computing  Multicore CPU Computing  Internet Technologies of the most common computing nodes of powerful computer systems. Stude	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared diffic optimization nemory interface  5 d defense. The focuses on lling detected  5 problems. They olve systems of as sequentially
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introduced will also learn the finite linear algebraic equation as well as in parallel. NIE-OSY This course is focused of	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths ici principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theoretic, formal languages and bioinformatics.  Hardware Security a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stuerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components into systems and test them for resistance to attacks. Stuerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. It is a solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  Internet Technologies  Internet Technologies  Internet including multimedia data transfer, with various types of network virtualization, and with last-mile security.  Multicore CPU Computing  Internet including multimedia data transfer, with various types of network virtualization, and with last-mile security.  Multicore to device the decrease in computing power due to the widening performance gap between the computational requirements of multi-non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.  Network Security  neoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically a ricipals of security mon	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph olied in the fields  5 e of the system owledge about  5 course focuses e problem of  5 and transfer  5 sors with shared diffic optimization nemory interface  5 d defense. The focuses on lling detected  5 problems. They olve systems of as sequentially  5 g context, virtual
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introduced will also learn the finite linear algebraic equation as well as in parallel. NIE-OSY This course is focused of memory, system calls, in	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths in troduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems of the combinatorial structures of the combinatorial structures. The theorems of the combinatorial structures are composed for the analysis and design of computer systems security solutions. Students get an overview of safegue hardware Security  In a knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegue hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will be able to safely use and integrate hardware components into systems and devices for internal security functions of the combinatorial system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discress of solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.  Modern Internet Technologies  In 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.  Multicore CPU Computing  Multicore CPU Computing  Internet Technologies of the most common computing nodes of powerful computer systems. Stude	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of  5 nd transfer  5 sors with shared diffic optimization nemory interface  5 d defense. The focuses on ling detected  5 problems. They olve systems of as sequentially  5 g context, virtual
NIE-GAK The goal of the class is on undestanding the ba coloring, Ramsey theor of combinatorics on wo NIE-HWB The course provides the using hardware means, the cryptographic accel NIE-MKY Students will gain deep on the problem of solvir factorization will also be NIE-MTI Students learn advance technologies of modern NIE-MCC Students will get acqua and virtually shared me techniques used to reduthroughput. On specific NIE-SIB The students will gain to course explains basic pexplanation and practic security events (i.e. inci NIE-NON) Students will be introduced will also learn the finite linear algebraic equation as well as in parallel. NIE-OSY This course is focused of memory, system calls, in	Graph theory and combinatorics to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algoriths ici principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theorems, formal languages and bioinformatics.  Hardware Security e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegue. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stuerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components. PuF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components. PuF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components. PuF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components. PuF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components. PuF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components. PuF, random number generators, smart cards, biometric devices, and devices for internal security functions of the components into systems based on lattices.  Mathematics for Cryptology a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discressive of polynomial equations on lattices.  Modern Internet Technologies do networking technologies and protocols for both local area networks and wide area networks. They get acquainted with rout internet, including multimedia data transfer, with	ms. The emphasis of topics from graph ry will be also approved by the second se	s will be not only and hypergraph blied in the fields  5 e of the system owledge about  5 course focuses a problem of  5 nd transfer  5 sors with shared diffic optimization nemory interface  5 d defense. The focuses on ling detected  5 problems. They olve systems of as sequentially  5 g context, virtual

NIE-SYP Parsing and Compilers

Z.ZK

5

The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.

NIE-REV Reverse Engineering

Z,ZK

\_\_\_\_\_

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-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-TES Systems Theory

Z,ZK

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.

#### NIE-TSP Testing and Reliability

Z,ZK

5

Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with built-in-self-test equipment. They will be able to compute, analyze, and control the reliability and availability of the designed circuits.

#### NIE-VCC Virtualization and Cloud Computing

Z,ZK

5

Students will gain 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).

Code of the group: NIE-V.21

Name of the group: Purely elective master's courses

Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NIE-BLO	Blockchain Josef Gattermayer, Jakub R ži ka, Marek Bielik Josef Gattermayer Josef Gattermayer (Gar.)	Z,ZK	5	1P+2C	Z	V
NIE-CPX	Complexity Theory Ond ej Suchý Dušan Knop Ond ej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	V
NIE-VYC	Computability  Jan Starý	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 <b>Hana Kubátová</b> Hana Kubátová (Gar.)	Z	4	2C	Z	V
NIE-SCE2	Computer Engineering Seminar Master II  Hana Kubátová	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	Z	2	4C	Z,L	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GLR	Games and reinforcement learning  Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GRI	Grid Computing  André Sopczak, Petr Fiedler Pavel Tvrdík André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-HMI	History of Mathematics and Informatics  Alena Šolcová Alena Šolcová (Gar.)	Z,ZK	3	2P+1C	Z	V
NIE-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola	Z,ZK	5	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan Tomáš Evan (Gar.)	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	Z,ZK	5	2P+1C	L	V

NIE-OSY	Operating Systems and Systems Programming Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-PAM	Parameterized Algorithms Ond ej Suchý	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 Miroslav epek	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 Tomáš Valla Tomáš Valla (Gar.)	KZ	5	4C	L	V
FIT-ACM2	Programming Practices 2 Ond ej Suchý Ond ej Suchý (Gar.)	KZ	5	4C	Z	V
FIT-ACM3	Programming Practices 3 Ond ej Suchý Ond ej Suchý (Gar.)	KZ	5	4C	L	V
FIT-ACM4	Programming Practices 4 Ond ej Suchý Ond ej Suchý (Gar.)	KZ	5	4C	Z	V
FIT-ACM5	Programming Practices 5 Ond ej Suchý Ond ej Suchý (Gar.)	KZ	5	4C	L	V
FIT-ACM6	Programming Practices 6 Ond ej Suchý Ond ej Suchý (Gar.)	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	Z,ZK	5	2P+1C	L	V
NIE-BPS	Wireless Computer Networks Alexandru Moucha	Z,ZK	4	2P+1C	L	V
NIE-SEP	World Economy and Business Tomáš Evan Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z	V
FITE-SEP	World Economy and Business Tomáš Evan Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+2C	Z	V

NIE-MVI	Computational Intelligence Methods	Z,ZK	5
Students will unders	stand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are p	1 '	d are applicabl
o solving a wide rar	nge of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuroevolution. Stu	dents will learn how	v these method
work and how to ap	ply them to problems related to data extraction, management, intelligence in games and optimisation, etc.		
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 a	ccess time and me	mory complexi
hey will be able to	use the knowledge in design of applications that utilize pattern matching.		
VIE-OSY	Operating Systems and Systems Programming	Z,ZK	5
his course is focus	ed on the design and implementation of the basic components that make up modern operating systems. This includes threads, p	rocesses, switchin	g context, virtu
nemory, system ca	lls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system are	chitecture with emp	hasis on the
ernel architecture.	Within the course, they will gain practical experience with the development of a small but fully functional operating system.		
NE-SYP	Parsing and Compilers	Z,ZK	5
he module builds u	pon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge	of various variants	and application
of I P nareing and a	re introduced to anguing applications of payagra, such as ingremental and payallel payaing		
i Lix paising and a	re introduced to special applications of parsers, such as incremental and parallel parsing.		
<u> </u>	Blockchain	Z,ZK	5
NIE-BLO		1 '	-
NIE-BLO Students will unders	Blockchain	atforms. They will b	e able to desig
NIE-BLO Students will unders code and deploy a selationship betwee	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares	atforms. They will b	e able to desig
NIE-BLO Students will unders ode and deploy a selationship betwee	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem.	atforms. They will b	e able to desig mphasis on th
NIE-BLO Students will unders ode and deploy a selationship betwee upervising implem	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares	atforms. They will b	e able to desig mphasis on th
NIE-BLO Students will unders code and deploy a selationship betwee supervising implem NIE-CPX	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares entation of blockchain-based solutions in both academia and business.	atforms. They will be ces an increased e the students for in Z,ZK	e able to design mphasis on the higher menting of the following of the fol
NIE-BLO Students will unders code and deploy a selationship betwee cupervising implem NIE-CPX Students will learn a	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares sentation of blockchain-based solutions in both academia and business.    Complexity Theory about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the complexity theory and different models of algoritms.	atforms. They will be ces an increased e the students for in Z,ZK	e able to design mphasis on the higher menting of the following of the fol
NIE-BLO Students will unders tode and deploy a selationship betwee supervising implem NIE-CPX Students will learn a in)tractability of diff	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares sentation of blockchain-based solutions in both academia and business.    Complexity Theory about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the complexity theory and different models of algoritms.	atforms. They will be ces an increased e the students for in Z,ZK	e able to design mphasis on the higher menting of the following of the fol
NIE-BLO Students will unders ode and deploy a selationship betwee supervising implem NIE-CPX Students will learn a in)tractability of diff NIE-VYC	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain placecure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares entation of blockchain-based solutions in both academia and business.    Complexity Theory about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of ficult problems.	atforms. They will be ces an increased et the students for in Z,ZK the theory concern	e able to desig mphasis on th aplementing o 5 ing practical
NIE-BLO Students will unders code and deploy a s relationship betwee supervising implem NIE-CPX Students will learn a in)tractability of diff NIE-VYC	Blockchain stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain plate secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place in blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares centation of blockchain-based solutions in both academia and business.  Complexity Theory about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of tricult problems.  Computability	atforms. They will be ces an increased et the students for in Z,ZK the theory concern	e able to desig mphasis on th aplementing o 5 ing practical

NIE-SCE1 Computer Engineering Seminar Master I 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.	Z se to failures and a	4
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of		
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers.	•	
semester.		
NIE-SCE2 Computer Engineering Seminar Master II	Z	4
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance.	_	
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of		
articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tead		
semester.	•	
NI-DSW Design Sprint	Z	2
Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to va	lidated prototype	in 5 days. During
the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting w	ith research and	finishing with
testing the prototypes (plus final presentation).		
NI-DID Digital drawing	Z	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p	erspective and co	lor theory, which
they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The cou	rse is fit for anyon	ne who wants to
practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice ga	ined knowledge.	
NI-GLR Games and reinforcement learning	Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intellig	. ' .	e is intended to
give you both theoretical and practical background so you can participate in related research activities. Presented in English.		
NI-GRI Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.	, ,	-
NIE-HMI History of Mathematics and Informatics	Z,ZK	3
The course focuses on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computers	'	_
for finding some relations 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
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 v	· '	-
of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	with the most fanc	damental notions
	Z.ZK	3
FITE-EHD Introduction to European Economic History  The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global e	, ,	
of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the econom		
area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial inst		
does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and		
meetings will consist of a mixture of lecture and discussion.	. o.gaa	motory: Glado
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 prin		-
selected notions from probability theory and statistics.	o.p.o, g.aa.o	ourodo) arra
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 architectures will be a considered by the control of the cont	'	
for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.		
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 nece		Į.
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	-	-
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity expe		
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial	-	
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent soluti		
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	s not exist. We
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.		
NIE-ROZ Pattern Recognition	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 s		1
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, ar	nd their numerical	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 characteris	'	-
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal inte		
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		
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		
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		-
the course, students will 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
This is a selective course for preparing talented student for representation in international programming contests.	· <del>· -</del>	
FIT-ACM2 Programming Practices 2	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.	114	, 0
FIT-ACM3 Programming Practices 3	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.	114	, ,
FIT-ACM4 Programming Practices 4	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.	114	, ,
3 3 35.55.1.0 000100 for proparing taloinou deutora for reproductitudes in international programming contests.		

FIT-ACM5	Programming Practices 5	KZ	5
	urse for preparing talented student for representation in international programming contests.	1	I
FIT-ACM6	Programming Practices 6	KZ	5
This is a selective cou	urse for preparing talented student for representation in international programming contests.	1	-
NIE-VPR	Research Project	Z	5
1. At the beginning of	the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partia	al tasks that should	be carried out
	f the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the		
Master these (MT) su	pervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for t	he courses BIE-B	AP, MIE-MPR,
MIE-DIP). Students, t	nen, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award t	ne assessment to	the IS based o
he confirmation of the	e external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the h	ead of the departn	nent responsib
or the topic of the M7	3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student f	or the upcoming se	emester should
aim at fine-tuning the	FT topic so that the FTT will be complete and approvable at the end of the semester.		
NIE-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
he students will lear	n the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web	technologies, met	nods and best
ractices for modellin	g, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowled	ge graphs and the	ir systematic
quality assurance.			
MI-SCE1	Computer Engineering Seminar Master I	Z	4
he Seminar of Comp	uter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistar	ce to failures and	attacks. Studer
are approached indivi	dually 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 scientifi
articles and other pro	fessional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	chers. The topics	are new for ea
semester.			
VIE-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedica	ted to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical att	acks. Students ge	familiar with
arious kinds of side	channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks a	nd get familiar wit	h higher-order
ttacks. They also get	practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information of the side-channel informatio	nation leakage.	
NIE-DDW	Web Data Mining	Z,ZK	5
Students will learn lat	est methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gai	n an overview of V	leb mining
echniques for Web cr	awling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an ow	erview of most rece	ent developme
n the field of social w	eb and recommendation systems.		
NIE-BPS	Wireless Computer Networks	Z,ZK	4
Students will learn ab	out the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in	ad-hoc networks,	multicast and
roadcast mechanisn	ns, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get kno	owledge of security	/ mechanisms
or wireless networks	and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.		
VIE-SEP	World Economy and Business	Z,ZK	4
he course introduce	s students of technical university to the international business. It does that predominantly by comparing individual countries ar	d key regions of v	orld economy
Students get to know	about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedo	m, corruption and	economic
levelopment, which a	re needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on	ndividual readings	. It is advised
ake bachelor level of	this course BIE-SEP as a prerequisite.		
FITE-SEP	World Economy and Business	Z,ZK	4
The course introduce	s students of technical university to the international business. It does that predominantly by comparing individual countries ar	d key regions of v	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	m, corruption and	economic
	re needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on		

take bachelor level of this 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
	This is a selective course for preparing talented student for representation in international programming contests.	•	
FIT-ACM2	Programming Practices 2	KZ	5
'	This is a selective course for preparing talented student for representation in international programming contests.	'	'
FIT-ACM3	Programming Practices 3	KZ	5
1	This is a selective course for preparing talented student for representation in international programming contests.	'	
FIT-ACM4	Programming Practices 4	KZ	5
ı	This is a selective course for preparing talented student for representation in international programming contests.	•	
FIT-ACM5	Programming Practices 5	KZ	5
1	This is a selective course for preparing talented student for representation in international programming contests.	'	'
FIT-ACM6	Programming Practices 6	KZ	5
ı	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 introduces a	selection of themes from the European economic history. It gives the student basic knowledge about forming of the global ec	conomy through the	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 economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. 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 history. Class meetings will consist of a mixture of lecture and discussion.

FITE-SEP World Economy and Business Z,ZK 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. MI-SCF1 Computer Engineering Seminar Master I 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 MIE-MZI Mathematics for data science In this course, the students are introduced to the domains of mathematics necessary for understanding the standard methods and algorithms used in data science. The studied topics include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle, gradient methods) and selected notions from probability theory and statistics. NI-AMI 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 recommendation systems, image processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed. NI-DID Digital drawing 2 The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color theory, which 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 who wants to practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge NI-DSW Design Sprint Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation). NI-GI R Games and reinforcement learning Z,ZK 4 The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligence. This course is intended to give you both theoretical and practical background so you can participate in related research activities. Presented in English. **Grid Computing** NI-GRI Z,ZK 5 Grid computing and gain knowledge about the world-wide network and computing infrastructure. Z.ZK NIE-ADM 5 **Data Mining Algorithms** 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). NIE-ADP Architecture and Design patterns Z.ZK 5 The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems. NIE-AIB Algorithms of Information Security Z,ZK Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems. Middleware Architectures 1 NIE-AM1 Z,ZK 5 Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications. This course replaces the course MIE-MDW. Z,ZK NIF-AM2 Middleware Architectures 2 5 Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. NIE-ARI Computer arithmetic Z,ZK 4 Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units. NIE-BKO Error Control Codes 7.7K 5 The course expands the basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mathematical theory and principles of linear, cyclic codes and codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to implement these detections and corrections for different types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunication channels. NIE-BLO Blockchain Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platforms. They will be able to design, code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places an increased emphasis on the relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the students for implementing or supervising implementation of blockchain-based solutions in both academia and business. **NIE-BPS** Wireless Computer Networks Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools **NIE-BVS Embedded Security** Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems.

NIE-CPX			1
	Complexity Theory	Z,ZK	5
Students will lear	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	theory concerning	g practical
	(in)tractability of difficult problems.		
NIE-DDW	Web Data Mining	Z,ZK	5
	arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain a		_
echniques for Web	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview	of most recent d	evelopme
	in the field of social web and recommendation systems.		
NIE-DIP	Diploma Thesis	Z	30
NIE-DSS	Decision Support Systems	Z,ZK	5
	rse is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of control of the con		
_	ented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will a		he principl
	conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods an		
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 p		
mannels. They lead	rn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that su data and services, and safety in case of failures.	ipport riigir avalia	ibility of bc
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
_	introduction to Discrete and Computational Geometry: to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with t		_
ne course interior	of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	ine most randam	critai riotio
NIE-EHW	Embedded Hardware	Z,ZK	5
	Embedded Flatdware		_
_	from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, in		
, ,	of internal communication, parallelism extraction and utilization in special structures and system architectures.	g	
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 focusions of the C++ programming language for software development.	,	_
	iciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor tir		-
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 bas		-
in C language and	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up	to sophisticated	technique
	combined with artificial intelligence.		
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowl	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access	time and memor	y complexi
	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
	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft	•	_
	· ·	•	
	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft	•	
Students are able t  NIE-GAK  The goal of the cla	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The properties of software is a software in the control of the c	Z,ZK The emphasis wil	llow to prov
Students are able t NIE-GAK The goal of the cla on undestanding th	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic	Z,ZK The emphasis will cs from graph and	Ilow to prov
Students are able t  NIE-GAK  The goal of the cla on undestanding th	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wi	Z,ZK The emphasis will cs from graph and	Ilow to produce 5 I be not on the hypergraph
NIE-GAK The goal of the cla on undestanding th coloring, Ramsey t	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.	Z,ZK The emphasis will cos from graph and II be also applied	5 I be not on d hypergraph in the field
NIE-GAK The goal of the cla on undestanding th coloring, Ramsey t	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming	Z,ZK The emphasis will cos from graph and II be also applied	5 I be not on hypergraph in the field
NIE-GAK The goal of the cla on undestanding th coloring, Ramsey t  NIE-GPU Students will gain k	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming chowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD	Z,ZK The emphasis will cos from graph and II be also applied  Z,ZK A programming 6	5 I be not or d hypergral in the field
NIE-GAK The goal of the cla on undestanding th coloring, Ramsey t  NIE-GPU Students will gain k	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics se is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Introduction to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational computational use of these hierarchical computational computational use of these hierarchical computational computations.	Z,ZK The emphasis will cos from graph and II be also applied  Z,ZK A programming 6	5 I be not on d hypergraph in the field
NIE-GAK The goal of the cla on undestanding th coloring, Ramsey t  NIE-GPU Students will gain k which is already a v	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Inowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational also learn optimization programming techniques and methods of programming multiprocessor GPU systems.	Z,ZK The emphasis will cos from graph and III be also applied Z,ZK A programming equational structure	5 I be not on d hypergraph in the field 5 environmentes, studen
NIE-GAK The goal of the cla on undestanding th coloring, Ramsey t  NIE-GPU Students will gain k which is already a v	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Innowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computations and programming multiprocessor GPU systems.  History of Mathematics and Informatics	Z,ZK The emphasis will cos from graph and III be also applied Z,ZK A programming a coutational structure Z,ZK	5 I be not on d hypergraph in the field 5 environmenters, studen
NIE-GAK The goal of the class on undestanding the coloring, Ramsey to the NIE-GPU Students will gain keyhich is already a volume.  NIE-HMI The course focuse	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Inowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computations are optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics  es on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science.	Z,ZK The emphasis will cos from graph and III be also applied Z,ZK A programming outational structure Z,ZK ence The topics a	5 I be not on d hypergraph in the field 5 environmenters, studen 3 are selected
NIE-GAK The goal of the class on undestanding the coloring, Ramsey to the NIE-GPU Students will gain keyhich is already a volume.  NIE-HMI The course focuse for finding s	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory with of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming chowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computing also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods.	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming a cutational structur Z,ZK ence The topics a ences will be sho	5 I be not on d hypergraph in the field free, studen 3 I selected by the selec
NIE-GAK The goal of the class on undestanding the coloring, Ramsey to the coloring, Ramsey to the coloring will gain know the coloring and the coloring that the coloring is already a visual section of the coloring is the c	Graph theory and combinatorics sis is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Introduction to program them mainly in the CVD processors. They will learn to program them mainly in the CVD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical compositions will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics  as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science one relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods.	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming outational structur Z,ZK ence The topics a ences will be sho Z,ZK	5 I be not on d hypergraph in the field free, studen 3 re selected by definition and the field free selected by definition and the field free selected by definition and the field free selected free selected free selected free selected free selected free free selected free free selected free free selected free free free free free free free fr
NIE-GAK The goal of the class on undestanding the coloring, Ramsey to the coloring, Ramsey to the coloring and the coloring a	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory with of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming chowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computing will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science are relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and side-Channel Analysis in Hardware dicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks.	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming a cutational structur Z,ZK ence The topics a ences will be sho Z,ZK s. Students get fa	5 I be not on d hypergraph in the field free, studen 3 re selected by selected by 4 amiliar with
NIE-GAK The goal of the class on undestanding the coloring, Ramsey to the coloring, Ramsey to the coloring and the coloring a	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming chowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computing will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science are relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science dicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks and get channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get channels.	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming of butational structure Z,ZK ence The topics a ences will be sho Z,ZK s. Students get fa get familiar with h	5 I be not on d hypergraph in the field from the fi
NIE-GAK The goal of the class on undestanding the coloring, Ramsey to the coloring to	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder theory winder and bioinformatics.  GPU Architectures and Programming  Introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winder theory winder and programming technology of graphs and combinatorial structures. The theory winder and programming theory, and programming the programming technology of graphs and combinatorial structures. The theory winder and programming the programming theory, and programming the programming technology of graphs and combinatorial structures. The theory winder and programming the graphs and programming	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming of outational structure Z,ZK ence The topics a ences will be sho Z,ZK s. Students get fa get familiar with hoformation leakage	5 I be not on d hypergraph in the field from the fi
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a very the course focuse for finding selections. NIE-HSC This course is de various kinds of selections. The course of selections attacks. Telections will be selected at the course of selections will be selected at the course of selections. The course is described attacks. Telections will be selected at the course of selections will be selected at the course of selections. The course is described attacks. The course of selections will be selected at the course of selections will be selected at the course of selections will be selected at the classical selections will be select	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming  Introduction of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computions will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics  as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science me relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science me relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and fee years of the side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks did they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information.  Hardware Security	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming of outational structure Z,ZK ence The topics a ences will be sho Z,ZK s. Students get faget familiar with horomation leakar Z,ZK	5 I be not or d hypergraph in the field servironments, studer 3 are selected by 4 amiliar with higher-order ge.
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification The course focusion for finding so NIE-HSC This course is de various kinds of so attacks. T NIE-HWB The course provide	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The ebasic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wis of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computed will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science and evices. It focuses on both theoretical analysis and practical attacks ide channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  Hardware Security  set the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming of outational structure Z,ZK ence The topics a ences will be sho Z,ZK s. Students get faget familiar with histormation leakar Z,ZK against abuse o	5 I be not or d hypergraph in the field from the fi
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a very NIE-HMI The course focuse for finding s NIE-HSC This course is de various kinds of s attacks. T NIE-HWB The course provide using hardware me	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind from the combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming Incovered programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computities and programming technology of GPU systems.  History of Mathematics and Informatics  as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  as the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learn, they will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learn, they will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learn, they will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learn, they will be able to safely use and integrate hardw	Z,ZK The emphasis will cs from graph and II be also applied Z,ZK A programming of outational structure Z,ZK An ence The topics a ences will be sho Z,ZK s. Students get fa get familiar with histormation leakan Z,ZK against abuse of ts will gain knowless.	5 I be not or d hypergraph in the field from the fi
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a very the course focusing for finding selections with the course is de various kinds of selections attacks. Telections in the course provide using hardware methe creation of the course provide using hardware methe creation in the course provide using hardware methe creation in the course provide using hardware methe creation in the course provide using hardware mether creations.	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical compositions will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science metaltions between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  set the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student protographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions.	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of outational structure Z,ZK Ence The topics a ences will be sho Z,ZK s. Students get familiar with histormation leakar Z,ZK against abuse of ts will gain knowl of the computer.	5 I be not or d hypergraph in the field servironment res, studer 3 are selected by 4 amiliar with higher-orde ge. 5 f the syste edge about
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a very the course focuse for finding selections will be various kinds of selections attacks. Telections are course provided using hardware menter of the course of the cour	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming moveledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computic will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science me relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science may be a computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and grey also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security solutions. Students get an overview of safeguards they also get practice in both designing the SCA countermeasures security solutions. Students get an overview of safeguards seans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student prographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal se	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of outational structure Z,ZK Ence The topics a ences will be sho Z,ZK s. Students get familiar with histormation leakar Z,ZK against abuse of ts will gain knowl of the computer. Z,ZK	5 I be not or d hypergral in the field from the field services, studer 3 are selected by 4 amiliar with higher-order ge. 5 f the syste edge about 5
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey the NIE-GPU Students will gain key thich is already a very NIE-HMI The course focuse for finding s NIE-HSC This course is de various kinds of s attacks. T NIE-HWB The course provide using hardware m the cry NIE-KOD Students are intro	Graph theory and combinatorics so is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The se basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming chowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computing will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  Est the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student prographic accelerators, PUF, random number generators, sma	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of outational structure Z,ZK Ence The topics a ences will be sho Z,ZK as Students get familiar with histormation leakar Z,ZK against abuse of ts will gain knowl of the computer. Z,ZK compression met	5   1 be not or of d hypergral in the fiel   5   5   5   5   5   6   7   6   6   6   6   6   6   6   6
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey the NIE-GPU Students will gain key thich is already a very NIE-HMI The course focuse for finding s NIE-HSC This course is de various kinds of s attacks. T NIE-HWB The course provide using hardware m the cry NIE-KOD Students are intro	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory winders and programming to the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD wildespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computer science and mathematics and Informatics  History of Mathematics and Informatics  Side-Channel Analysis in Hardware dicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  set knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student bears into systems and test them for resistance to attacks. Students learn to implement various profiled and non-profiled attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  Bath Amalysis and the get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learns to implement various profiled attacks and get eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learns, profiled attacks and get an overview of safeguards eans. They wi	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of outational structure Z,ZK Ence The topics a ences will be sho Z,ZK as Students get familiar with histormation leakar Z,ZK against abuse of ts will gain knowl of the computer. Z,ZK compression met	5   1 be not or of d hypergrating the field of the fiel
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a very the course for finding selection of the course is devarious kinds of selection attacks. Telection of the course provide using hardware ments of the course of the course provide using hardware ments of the course of the course provide using hardware ments of the course of t	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical comparties will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science one relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and give channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and give also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  Bardware Security  Bardware Security  Bardware Security  Bardware Security  Bardware Security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student prographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functi	Z,ZK The emphasis will cs from graph and ill be also applied Z,ZK A programming of butational structure Z,ZK Ence The topics a ences will be sho Z,ZK s. Students get familiar with histormation leakar Z,ZK against abuse o ts will gain knowl of the computer. Z,ZK compression met ints learn the fund	5 I be not or d hypergral in the field fine the fie
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification NIE-HMI The course focuse for finding s NIE-HSC This course is de various kinds of s attacks. T NIE-HWB The course provide using hardware mention the cry NIE-KOD Students are introdused in practice. The	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The abasic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory with of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming movedage of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical compositions will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics  so on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics and programming mathematics and logic - useful for today computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get paractice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  set the knowledge needed for the an	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of putational structure Z,ZK A gagainst abuse of the swill gain knowl of the computer. Z,ZK Compression met ints learn the functional structure Z,ZK Compression met ints learn the functional structure Z,ZK	5 I be not on d hypergraph in the field by the field state of the system of the field state of the field state of the field state of the system of the sys
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification NIE-HMI The course focuse for finding s NIE-HSC This course is de various kinds of s attacks. T NIE-HWB The course provide using hardware mention the cry NIE-KOD Students are introdused in practice. The	Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be able to safety use and history of combinatorial structures and Programming included to the basic principles of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical comparisons on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks are given along the parallel of the side-channel information in the side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks are given along the profiled profiled attacks and profiled profiled the side-channel in the side of the side-channel in the side of the side-channel in the side of the side profiled attacks and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks are given and the side profiled that and the profiled and profiled attacks and the profiled profiled that are given and the profiled to the side channel integrate hardware components	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of putational structure Z,ZK A gagainst abuse of the swill gain knowl of the computer. Z,ZK Compression met ints learn the functional structure Z,ZK Compression met ints learn the functional structure Z,ZK	5 I be not on d hypergraph in the field by the field state of the system of the field state of the field state of the field state of the system of the sys
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey the NIE-GPU Students will gain keyhich is already a verification NIE-HMI The course focuse for finding selection of selection attacks. The course provide using hardware mention the crystal selection of the	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics so is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical compartial size learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  Hardware Security  Bate Compression  Hardware Security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learns to inspect to the safety of the side-channel integrate hardware components into systems and tes	Z,ZK The emphasis will cs from graph and III be also applied Z,ZK A programming of putational structure Z,ZK A gagainst abuse of the computer. Z,ZK Compression met into learn the functional structure Z,ZK A compression met into select and im	5 I be not on d hypergraph in the field by the field state of the system
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification IThe course focuses for finding selection of selection attacks. The course provide using hardware method using hardware method using hardware in the crystal students are introduced in practice. The NIE-KOP The students will get in the course in the crystal students are introduced in practice. The NIE-KOP The students will get in the course in the crystal students will get in the crystal students will get in the course in the crystal students will get in the course in the crystal students will get in the crystal students will get in the course in the crystal students will get in the course in the crystal students will get in the course	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical compositions will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science one relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and general and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and general sand they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and general sand they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and general sand they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and general	Z,ZK The emphasis will cs from graph and ill be also applied Z,ZK The programming of putational structure Z,ZK The emphasis will be also applied Z,ZK The programming of putational structure Z,ZK The programming of putational structure Z,ZK The sence The topics at the ences will be shown Z,ZK The sence The topics at the formation leaked Z,ZK The sence The topics at the formation leaked Z,ZK The sence The sence The sence The sence The function of the computer. The sence The function of the computer of the computer of the sence T,ZK The sence The function of the computer of the sence T,ZK The sence The sence T,ZK The sence The sence T th	5 I be not on d hypergraph in the field by the field state of the system
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification NIE-HMI The course focuse for finding selection NIE-HSC This course is devarious kinds of selection attacks. Telection NIE-HWB The course provide using hardware method the crystal selection NIE-KOD Students are introdused in practice. The NIE-KOP The students will generally selection NIE-KRY Students will learn	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some soft basic properties of software.  Graph theory and combinatorics so is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical compartial size learn optimization programming techniques and methods of programming multiprocessor GPU systems.  History of Mathematics and Informatics as on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science relations between computer science and mathematical methods. Some examples of applications of mathematics to computer science and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and they also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  Hardware Security  Bate Compression  Hardware Security solutions. Students get an overview of safeguards eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students learns to inspect to the safety of the side-channel integrate hardware components into systems and tes	Z,ZK The emphasis will cs from graph and ill be also applied Z,ZK The programming of putational structure Z,ZK The topics a gences will be shown Z,ZK The solution of the computer. Z,ZK The solution of the computer. Z,ZK The computer of the computer of the computer. Z,ZK The computer of the computer of the computer. Z,ZK The computer of the com	5 I be not on d hypergraph in the field by the field state of the system
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification NIE-HMI The course focuse for finding selection NIE-HSC This course is devarious kinds of selection attacks. Telection NIE-HWB The course provide using hardware method the crystal selection NIE-KOD Students are introdused in practice. The NIE-KOP The students will generally selection NIE-KRY Students will learn	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. I e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wind of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical comparities and selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and hardware devices. It focuses on both theoretical analysis and practical attacks did channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and ghey also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel in Hardware Security  set the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards eass. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Student programpic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions.  Data Compression  Combinatorial Optimization  Jain knowledge and understanding necessary deployment of combinatorial heuristics at a profes	Z,ZK The emphasis will cs from graph and ill be also applied Z,ZK The programming of putational structure Z,ZK The topics a gences will be shown Z,ZK The solution of the computer. Z,ZK The solution of the computer. Z,ZK The computer of the computer of the computer. Z,ZK The computer of the computer of the computer. Z,ZK The computer of the com	5 I be not on d hypergraph in the field of hypergraph in the hyper
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification NIE-HMI The course focuse for finding selection NIE-HSC This course is devarious kinds of selection attacks. Telection NIE-HWB The course provide using hardware method the crystal selection NIE-KOD Students are introdused in practice. The NIE-KOP The students will generally selection NIE-KRY Students will learn	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. I e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing combinatorial structures and programming introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing combinatorial structures and programming introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing combinatorial structures and programming introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory wing combinatorial structures and programming manual structures and programming manual structures. The theory wing combinatorial structures and programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computividespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computividespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computividespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computers and programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computers and programming technology of GPU processors.  History of Mathematics and Informatics  Side-Channel Analysis in Hardware  dicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attack and gotic	Z,ZK The emphasis will cs from graph and ill be also applied Z,ZK The programming of putational structure Z,ZK The topics a gences will be shown Z,ZK The solution of the computer. Z,ZK The solution of the computer. Z,ZK The computer of the computer of the computer. Z,ZK The computer of the computer of the computer. Z,ZK The computer of the com	5 I be not on d hypergraph in the field of hypergraph in the hyper
NIE-GAK The goal of the cla on undestanding the coloring, Ramsey to NIE-GPU Students will gain keyhich is already a verification of the course for finding so NIE-HSC This course is devarious kinds of so attacks. T NIE-HWB The course provide using hardware method the cry NIE-KOD Students are introdused in practice. The NIE-KOP The students will garry random number general course in the cry NIE-KRY Students will learn random number general course in the cry NIE-KRY Students will learn random number general course in the cry NIE-KRY Students will learn random number general course in the cry NIE-KRY	Graph theory and combinatorics sis to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. Is e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topic heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory with of combinatorics on words, formal languages and bioinformatics.  GPU Architectures and Programming mowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUD widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computers selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical methods. Some examples of applications of mathematics to computer science and mathematical principles of integrate hardware components into systems and test them for re	Z,ZK The emphasis will cs from graph and ill be also applied Z,ZK The programming of putational structure Z,ZK The ence The topics a gences will be shown and the structure Z,ZK The students get familiar with performation leaker Z,ZK The students get familiar with performance in the students get familiar with	5 I be not on d hypergraph in the field of hypergraph in the hyper

techniques used to reduce 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 app	· · · · · · · · · · · · · · · · · · ·				
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 app	, , , , , , , , , , , , , , , , , , , ,				
implementation of processes, organisation structures and information support in big enterprises and institutions.  NIE-MKY  Mathematics for Cryptology	Z,ZK 5				
NIE-MKY   Mathematics for Cryptology Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.					
on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of dis					
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based					
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-var					
and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation.	•				
numerical algorithm and their stability analysis. The topics are completed with the demonstration of applications in computer science. The course for argumentation.	cuses on clear presentation and				
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 partia	l I				
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 en	nd of the semester. 2. The externa				
supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.	•				
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 to					
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 the	at the FTT will be complete 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 r					
technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-n	- ·				
NIE-MVI Computational Intelligence Methods	Z,ZK 5				
Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are pa	rallel 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. Stud	ents will learn how these methods				
work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation					
NIE-NON   Nonlinear Continuous Optimization and Numerical Methods	Z,ZK   5				
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such met will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. T	•				
linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement the indication of the continuous problems and iterative algorithms.					
as well as in parallel.					
NIE-NSS Normalized Software Systems	ZK 5				
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineer	ring, 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 is					
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements	·				
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stab  This knowledge allows students to realize new levels of evolvability in software architectures.	ility and entropy-related principles				
NIE-NUR User Interface Design	Z,ZK 5				
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, for	1 1				
notions and procesures. They get acquainted with graphical, speech, and multimodal Uls. Thanks to the gained knowledge, the students will be	able to design advanced Uls.				
NIE-OSY Operating Systems and Systems Programming	Z,ZK 5				
This course is focused on the design and implementation of the basic components that make up modern operating systems. This includes threads, proceedings are the state of the	<del>-</del>				
memory, system calls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system are	•				
kernel architecture. Within the course, they will gain practical experience with the development of a small but fully functional oper  NIE-PAM  Parameterized Algorithms	Z,ZK 4				
NIE-PAM   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.	1 '				
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often					
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity experience.	onentially in this (small) parameter				
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial					
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent sol	•				
plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximately exponential algorithms.	" "				
NIE-PDB Advanced Database Systems	Z,ZK 5				
Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database of the course deals with new concepts of the course deals with new concepts of the course deals with new concepts of the course database of the course deals with new concepts of the course deals with new concepts of the course database of the c	1 ' 1				
databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CY					
the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PD	В.				
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	-				
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su	ch as computer vision and natura				
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 or	1 ' 1				
are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these pla	·				
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	•				
learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The cou	rse 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 business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of business process.					
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					

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. NIF-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 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 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 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). Computer Engineering Seminar Master I 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 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 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** 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 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. Systems Theory Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems. Testing and Reliability **NIE-TSP** 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 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 7 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.

For updated information see <a href="http://bilakniha.cvut.cz/en/FF.html">http://bilakniha.cvut.cz/en/FF.html</a> Generated: day 2025-10-22, time 03:13.