Studijní plán

Název plánu: Master specialization Computer Security, in English, 2021

Součást ČVUT (fakulta/ústav/další): Fakulta informačních technologií

Katedra:

Obor studia, garantovaný katedrou: Úvodní stránka

Garant oboru studia.:

Program studia: Informatics

Typ studia: Navazující magisterské prezenční

Předepsané kredity: 98

Kredity z volitelných předmětů: 22 Kredity v rámci plánu celkem: 120

Poznámka k plánu: The study plan is intended for those students who have been accepted to study since the academic year 2021/2022. . Guarantor: prof. Ing. Róbert Lórencz, CSc., email: robert.lorencz@fit.cvut.cz

Název bloku: Povinné předměty programu

Minimální počet kreditů bloku: 63

Role bloku: PP

Kód skupiny: NIE-PP.21

Název skupiny: Compulsory Courses of Master Study Program, Version 2021

Podmínka kredity skupiny: V této skupině musíte získat 63 kreditů

Podmínka předměty skupiny: V této skupině musíte absolvovat 6 předmětů

Kredity skupiny: 63 Poznámka ke skupině:

Kód	Název předmětu / Název skupiny předmětů (u skupiny předmětů seznam kódů jejích členů) Vyučující, autoři a garanti (gar.)	Zakončení	Kredity	Rozsah	Semestr	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 Zdeněk Muzikář Zdeněk Muziká ř Zdeněk Muzikář (Gar.)	Z	30	270ZP	L,Z	PP
NIE-MPR	Master Project Zdeněk Muzikář Zdeněk Muzikář (Gar.)	Z	7		Z,L	PP
NIE-MPI	Mathematics for Informatics Francesco Dolce Štěpán Starosta Štěpán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NIE-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík Pavel Tvrdík (Gar.)	Z,ZK	6	2P+2C	L	PP
NIE-VSM	Selected statistical Methods Petr Novák Pavel Hrabák Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

Charakteristiky předmetů této skupiny studijního plánu: Kód=NIE-PP.21 Název=Compulsory Courses of Master Study Program, Version 2021

NIE-KOP	Combinatorial Optimization	Z,ZK	6					
The students will gain	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 evalu	ate heuristics for practical problems.							
NIE-DIP	Diploma Thesis	Z	30					
NIE-MPR	Master Project	Z	7					

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

NIE-MPI Mathematics for Informatics Z,ZK 7

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

Parallel and Distributed Programming

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

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

Název bloku: Povinné předměty specializace

Minimální počet kreditů bloku: 35

Role bloku: PS

Kód skupiny: NIE-PB-PS.21

Název skupiny: Compulsory Courses of Master Specialization Computer Security, Version 2021

Podmínka kredity skupiny: V této skupině musíte získat 35 kreditů

Podmínka předměty skupiny: V této skupině musíte absolvovat 7 předmětů

Kredity skupiny: 35 Poznámka ke skupině:

Poznanka ke skupine.						
Kód	Název předmětu / Název skupiny předmětů (u skupiny předmětů seznam kódů jejích členů) Vyučující, autoři a garanti (gar.)	Zakončení	Kredity	Rozsah	Semestr	Role
NIE-KRY	Advanced Cryptology Jiří Buček, Róbert Lórencz Jiří Buček Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	PS
NIE-AIB	Algorithms of Information Security Martin Jureček Martin Jureček Martin Jureček (Gar.)	Z,ZK	5	2P+1C	Z	PS
NIE-HWB	Hardware Security Jiří Buček Jiří Buček (Gar.)	Z,ZK	5	2P+2C	L	PS
NIE-MKY	Mathematics for Cryptology Martin Jureček, Róbert Lórencz, Olha Jurečková Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	PS
NIE-SIB	Network Security Tomáš Zahradnický, Jiří Dostál, Simona Fornůsek, Gramoz Cubreli Simona Fornůsek Simona Fornůsek (Gar.)	Z,ZK	5	2P+1C	L	PS
NIE-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	PS
NIE-SBF	System Security and Forensics Tomáš Zahradnický, Jiří Buček, Simona Fornůsek, Marián Svetlík Simona Fornůsek Simona Fornůsek (Gar.)	Z,ZK	5	2P+1C	Z	PS

Charakteristiky předmetů této skupiny studijního plánu: Kód=NIE-PB-PS.21 Název=Compulsory Courses of Master Specialization Computer Security, Version 2021

NIE-KRY Advanced Cryptology

Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions.

NIE-AIB Algorithms of Information Security

Z,ZK Studenti se seznámí s algoritmy bezpečného generování klíčů a kryptografickým zpracováním chybových (nejen biometrických) dat. Dále se studenti seznámí s matematickými principy kryptografických protokolů (identifikačních, autentizačních a podpisových schémat). Získají znalosti o metodách detekce malware a použití strojového učení v detekčních algoritmech. Taktéž se seznámí s metodami vytváření steganografických záznamů, s metodami pro jejich vyhledávání a s útoky na ně.

NIE-HWB Z,ZK Hardware Security

The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer.

NIE-MKY Mathematics for Cryptology Z.ZK

Studenti získají hlubší znalosti o algebraických postupech řešících nejdůležitější matematické problémy, na kterých je založena bezpečnost šifer. Zejména se jedná o problém řešení soustavy polynomiálních rovníc nad konečným tělesem, problém faktorizace velkých čísel a problém diskrétního logaritmu. Problém faktorizace bude speciálně řešen i na eliptických křivkách. Studenti se rovnež seznámí s moderními šifrovacími systémy založenými na počítání na mřížce.

NIE-SIB **Network Security** Z,ZK

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-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

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).

Název bloku: Volitelné předměty Minimální počet kreditů bloku: 0

Role bloku: V

Kód skupiny: NIE-PB-VS.21

Název skupiny: Elective Vocational Courses for Master Specialization Computer security

Podmínka kredity skupiny: Podmínka předměty skupiny:

Kredity skupiny: 0

Poznámka ke sku	ipině: Compulsory courses of all speci	alizations wi	th the ex	ception c	of this spec	ialization.
Kód	Název předmětu / Název skupiny předmětů (u skupiny předmětů seznam kódů jejích členů) Vyučující, autoři a garanti (gar.)	Zakončení	Kredity	Rozsah	Semestr	Role
NIE-PDB	Advanced Database Systems Martin Svoboda Martin Svoboda (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-PIS	Advanced Information Systems Petr Kroha, Petra Pavlíčková Petra Pavlíčková Petr Kroha (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-ADP	Architecture and Design patterns Jiří Borský, Jan Kurš, Jan Zimolka, Marek Bělohoubek Jan Kurš Jan Kurš (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MVI	Computational Intelligence Methods Miroslav Čepek, Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-KOD	Data Compression Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-ADM	Data Mining Algorithms Rodrigo Augusto Da Silva Alves Rodrigo Augusto Da Silva Alves Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	٧
NIE-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-DSV	Distributed Systems and Computing Pavel Tvrdík, Peter Macejko Peter Macejko Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BVS	Embedded Security Jiří Buček, Martin Novotný Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-BKO	Error Control Codes Pavel Kubalik Pavel Kubalik (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-GPU	GPU Architectures and Programming Ivan Šimeček Ivan Šimeček Ivan Šimeček (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V
NIE-AM1	Middleware Architectures 1 Tomáš Vitvar, Milan Dojčinovski, Jaroslav Kuchař Jaroslav Kuchař Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MTI	Modern Internet Technologies Viktor Černý, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-MCC	Multicore CPU Computing Daniel Langr, Ivan Šimeček Ivan Šimeček (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-SIB	Network Security Tomáš Zahradnický, Jiří Dostál, Simona Fornůsek, Gramoz Cubreli Simona Fornůsek Simona Fornůsek (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5	2P+1C	Z,L	V
NIE-NSS	Normalized Software Systems Jan Verelst, Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	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-TES	Systems Theory Tomáš Kolárik, Stefan Ratschan, Jiří Vyskočil Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-TSP	Testing and Reliability Petr Fišer Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NIE-NUR	User Interface Design Josef Pavlíček Josef Pavlíček (Gar.)	Z,ZK	5	2P+1C	Z	V
NIE-VCC	Virtualization and Cloud Computing Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V

Charakteristiky předmetů této skupiny studijního plánu: Kód=NIE-PB-VS.21 Název=Elective Vocational Courses for Master Specialization Computer security

NIE-SIB Network Security Z,ZK

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).

Advanced Database Systems NIE-PDB

Z,ZK

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

The aim of this course is to provide students with practical knowledge of the basic principles of object-oriented design and its analysis, together with an understanding of the challenges, questions and compromises associated with advanced software design. In the first part of the course, students will review and deepen their knowledge of object-oriented programming and learn the most commonly used design patterns, which represent the best practices for solving typical software design problems. In the second part of the course, students will be introduced to the principles of design and analysis of software architecture including classical architectural designs, component systems and some advanced software architectures of large distributed systems. If you need to contact the teacher of NIE-ADP, please write an e-mail to Ing. Jiri Borsky borskjir@fit.cvut.cz

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

Z,ZK

5

Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data compression methods being used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, students learn the fundamentals of lossy data compression methods used in image, audio, and video compression.

NIE-ADM **Data Mining Algorithms**

Z,ZK

5

The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods).

NIE-SIM Digital Circuit Simulation and Verification

Z.ZK

5

Aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers today recent verification methods, too.

NIE-DSV Distributed Systems and Computing

Z,ZK

5

5

Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communication channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that support high availability of both data and services, and safety in case of failures.

NIE-EPC Effective C++ programming

Z,ZK

Students learn how to use the modern features of contemporary versions of the C++ programming language for software development. The course focuses on programming effectivity and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time requirements.

Efficient Text Pattern Matching Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access time and memory complexity.

They will be able to use the knowledge in design of applications that utilize pattern matching.

NIE-EHW **Embedded Hardware**

Z,ZK

5

The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures.

NIE-BVS Embedded Security

Z,ZK

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-ESW Embedded Software

Z,ZK

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

NIE-BKO **Error Control Codes** 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 Formal Methods and Specifications 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-GPU **GPU Architectures and Programming** Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUDA programming environment, which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational structures, students will also learn optimization programming techniques and methods of programming multiprocessor GPU systems. Graph theory and combinatorics 7.7K The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The emphasis will be not only on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topics from graph and hypergraph coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be also applied in the fields of combinatorics on words, formal languages and bioinformatics. 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-MTI Modern Internet Technologies 5 Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquainted with routing techniques and transfer technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security. Multicore CPU Computing Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications. Nonlinear Continuous Optimization and Numerical Methods Z.ZK Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods to real-world problems. They will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They will learn to solve systems of linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement these algorithms sequentially **NIE-NSS** Normalized Software Systems ΖK 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-OSY Operating Systems and Systems Programming Z.ZK This course is focused on the design and implementation of the basic components that make up modern operating systems. This includes threads, processes, switching context, virtual memory, system calls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system architecture with emphasis on the kernel architecture. Within the course, they will gain practical experience with the development of a small but fully functional operating system. Parsing and Compilers The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing. Z,ZK**NIE-TES** 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. **NIE-TSP** Testing and Reliability Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of User Interface Design 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 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

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.

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. This course replaces MIE-MDW.

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).

Kód skupiny: NIE-V.21

Název skupiny: Purely elective master's courses

Podmínka kredity skupiny: Podmínka předměty skupiny:

Kredity skupiny: 0

Poznámka ke skupině:

Kód	Název předmětu / Název skupiny předmětů (u skupiny předmětů seznam kódů jejích členů) Vyučující, autoři a garanti (gar.)	Zakončení	Kredity	Rozsah	Semestr	Role
NIE-BLO	Blockchain Josef Gattermayer, Jakub Růžička, Marek Bielik Josef Gattermayer Josef Gattermayer (Gar.)	Z,ZK	5	1P+2C	Z	V
NIE-CPX	Complexity Theory Ondřej Suchý Dušan Knop Ondřej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	٧
NIE-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-MVI	Computational Intelligence Methods Miroslav Čepek, Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	٧
NIE-ARI	Computer arithmetic Pavel Kubalik Pavel Kubalik (Gar.)	Z,ZK	4	2P+1C	Z,L	٧
NIE-SCE1	Computer Engineering Seminar Master I Hana Kubátová Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	Z	V
NIE-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L	V
NI-DSW	Design Sprint Ondřej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	٧
NI-DID	Digital drawing Denisa Nováčková Denisa Nováčková (Gar.)	Z	2	4C	Z,L	٧
NIE-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	٧
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	٧
NI-GRI	Grid Computing André Sopczak, Petr Fiedler Pavel Tvrdík André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	٧
NIE-HMI	History of Mathematics and Informatics Alena Šolcová Alena Šolcová Alena Šolcová (Gar.)	Z,ZK	3	2P+1C	Z	٧
NIE-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	3	2P+1C	L	٧
MIE-MZI	Mathematics for data science Štěpán Starosta	Z,ZK	4	2P+1C	L	٧
NIE-AM2	Middleware Architectures 2 Milan Dojčinovski Milan Dojčinovski (Gar.)	Z,ZK	5	2P+1C	L	٧
NIE-OSY	Operating Systems and Systems Programming Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	٧
NIE-PAM	Parameterized Algorithms Ondřej Suchý Ondřej Suchý (Gar.)	Z,ZK	4	2P+1C	L	٧
NIE-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	٧
NIE-ROZ	Pattern Recognition Michal Haindl Michal Haindl (Gar.)	Z,ZK	5	2P+1C	Z	٧
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	Pokročilé techniky strojového učení Zdeněk Buk, Miroslav Čepek, Petr Šimánek, Rodrigo Augusto Da Silva Alves, Vojtěch Rybář Miroslav Čepek Miroslav Čepek (Gar.)	Z,ZK	5	2P + 1C	L	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)	KZ	5	2P+1C	Z	٧
FIT-ACM1	Programovací praktika 1 Tomáš Valla Tomáš Valla (Gar.)	KZ	5	4C	L	V
FIT-ACM2	Programovací praktika 2 Tomáš Valla Ondřej Suchý (Gar.)	KZ	5	4C	Z	٧
FIT-ACM3	Programovací praktika 3 Ondřej Suchý Ondřej Suchý (Gar.)	KZ	5	4C	L	٧
FIT-ACM4	Programovací praktika 4 Ondřej Suchý Ondřej Suchý (Gar.)	KZ	5	4C	z	٧
FIT-ACM5	Programovací praktika 5 Ondřej Suchý Ondřej Suchý (Gar.)	KZ	5	4C	L	٧
FIT-ACM6	Programovací praktika 6 Ondřej Suchý Ondřej Suchý (Gar.)	KZ	5	4C	L	٧
NIE-VPR	Research Project Štěpán Starosta Štěpán Starosta Štěpán Starosta (Gar.)	Z	5		Z,L	V
NIE-SWE	Semantic Web and Knowledge Graphs Milan Dojčinovski Milan Dojčinovski Milan Dojčinovski (Gar.)	Z,ZK	5	2P+1C	Z	٧
MI-SCE1	Seminář počítačového inženýrství l Hana Kubátová	Z	4	2C	L,Z	٧
NIE-HSC	Side-Channel Analysis in Hardware Vojtěch Miškovský, Petr Socha Vojtěch Miškovský Vojtěch Miškovský (Gar.)	Z,ZK	4	2P+2C	Z	V

	Web Data Mining Milan Dojčinovski Milan Dojčinovski (Gar.)	Z,ZK	5	2P+1C	L	V
NIE-BPS	Wireless Computer Networks Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-SEP	World Economy and Business Tomáš Evan 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
Charakteristiky před	lmetů této skupiny studijního plánu: Kód=NIE-V.21 Název=Pure	ely elective ma	ster's co	ourses		
	omputational Intelligence Methods	aditional artificial int	alliganga g	,	ZK	5
	ne basic methods and techniques of computational intelligence, which are based on tra problems. The subject is also devoted to modern neural networks and the ways in which					
	m to problems related to data extraction, management, intelligence in games and optir	misation, etc.				
1	fficient Text Pattern Matching efficient algorithms for text pattern matching. They learn to use so called succinct data s	tructures that are of	ficient in ho	,	ZK and mem	5
-	e knowledge in design of applications that utilize pattern matching.	indictares trial are er	noicht in bo	iii access iiiii	z ana mem	iory complexity.
	perating Systems and Systems Programming				ZK	5
	he design and implementation of the basic components that make up modern operating rrupts and interactions of SW and HW using drivers. Students will learn the theory of t					
	the course, they will gain practical experience with the development of a small but fully				mar ompi	14010 011 1110
	arsing and Compilers				ZK	5
•	knowledge of fundamentals of automata theory, formal language and formal translation duced to special applications of parsers, such as incremental and parallel parsing.	i theories. Students (gain knowle	dge of various	s variants a	ind applications
	lockchain			Z,	ZK	5
	e foundations of blockchain technology, smart contract programming, and gain an over				-	_
• •	decentralized application, and assess whether integration of a blockchain is suitable fo chains and information security. It is concluded with a defense of a research or appliec			-		-
•	n of blockchain-based solutions in both academia and business.					
l l	omplexity Theory		:!: -	,	ZK	5
in)tractability of difficult pr	ne fundamental classes of problems in the complexity theory and different models of all oblems.	igoritms and about	implications	s of the theory	concernir	ng practical
VIE-VYC C	omputability			Z,	ZK	4
	ve functions and effective computability.				717	
	omputer arithmetic data representations used in digital devices and will be able to design arithmetic operation.	ations implementati	on units.	Z,	ZK	4
	omputer Engineering Seminar Master I				Z	4
·	Engineering is a (s)elective course for students who want to deal with deeper topics of d		-			
	y within the subject. Each student or group of students solves some interesting topic w onal literature and/or work in KČN laboratories. The capacity of the subject is limited by			-		
semester.	mai moralare arai in moral maseralement in capacity of the casposite in moral sy	and poodisinated or			o topico a.	
l l	omputer Engineering Seminar Master II			I	Z	4
The Seminar of Computer	Engineering is a (s)elective course for students who want to deal with deeper topics of d		-	stance to failu	res and at	tacks. Students
The Seminar of Computer are approached individual		vith the selected sup	pervisor. Pa	stance to failurt of the subje	res and at	tacks. Students with scientific
The Seminar of Computer are approached individual articles and other professi semester.	Engineering is a (s)elective course for students who want to deal with deeper topics of d y within the subject. Each student or group of students solves some interesting topic w onal literature and/or work in KČN laboratories. The capacity of the subject is limited by	vith the selected sup	pervisor. Pa	stance to failurt of the subject teachers. Th	res and at ect is work e topics ar	tacks. Students with scientific re new for each
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incognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects. NI-PML 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 probability. In the commental probability of the pr	NIE-ROZ Pattern Recognition	Z,ZK	5
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FITE-SEP World Economy and Business Z,ZK 4

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Seznam předmětů tohoto průchodu:

Kód	Název předmětu	Zakončení	Kredity
FIT-ACM1		KZ	
· ·	Programovací praktika 1 Tento výběrový kurz má za cíl připravit ty nejlepší studenty na reprezentaci fakulty v rámci mezinárodních ACM soutěží.		5
FIT-ACM2	Programovací praktika 2 Tento výběrový kurz má za cíl připravit ty nejlepší studenty na reprezentaci fakulty v rámci mezinárodních ACM soutěží.	KZ	5
FIT-ACM3	Programovací praktika 3 Tento výběrový kurz má za cíl připravit ty nejlepší studenty na reprezentaci fakulty v rámci mezinárodních ACM soutěží.	KZ	5
FIT-ACM4	Programovací praktika 4 Tento výběrový kurz má za cíl připravit ty nejlepší studenty na reprezentaci fakulty v rámci mezinárodních ACM soutěží.	KZ	5
FIT-ACM5	Programovací praktika 5 Tento výběrový kurz má za cíl připravit ty nejlepší studenty na reprezentaci fakulty v rámci mezinárodních ACM soutěží.	KZ	5
FIT-ACM6	Programovací praktika 6 Tento výběrový kurz má za cíl připravit ty nejlepší studenty na reprezentaci fakulty v rámci mezinárodních ACM soutěží.	KZ	5
FITE-EHD	Introduction to European Economic History	Z,ZK	3
key historical periods. the Roman Empire to	a selection of themes from European economic history. It gives the student basic knowledge about forming of the global economy. As European countries have been dominant actors in this process it focuses predominantly on their roles in economic history. Fro the fragmentation of the Middle Ages, from the destruction of WWII to the current affairs, the development of modern financial in rithe detailed economic history of particular European countries but rather the impact of trade and the role of particular events, insingular history. Class meetings will consist of a mixture of lectures and discussions.	m the large econo stitutions is deciph	mic area of nered. The
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large distributed systems. If you need to contact the teacher of NIE-ADP, please write an e-mail to Ing. Jiri Borsky borskjir@fit.cvut.cz

NUE AID	Almonishum of Information Consults	7 71/	
NIE-AIB Studenti se seznám	Algorithms of Information Security í s algoritmy bezpečného generování klíčů a kryptografickým zpracováním chybových (nejen biometrických) dat. Dále se studenti sezi	Z,ZK námí s matematick	5 vými principy
	otokolů (identifikačních, autentizačních a podpisových schémat). Získají znalosti o metodách detekce malware a použití strojového uč		
<i>,</i> , , , , , , , , , , , , , , , , , ,	Taktéž se seznámí s metodami vytváření steganografických záznamů, s metodami pro jejich vyhledávání a s útoky na ně.		J
NIE-AM1	Middleware Architectures 1	Z,ZK	5
	y new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information systems of the concepts and technologies in the area of service-oriented architectures. The	,	
architecture and apl	ication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm	unications and hig	gh availability
NIE-AM2	of applications. This course replaces the course MIE-MDW. Middleware Architectures 2	Z,ZK	5
l l	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture	•	1
	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 implementations	tion units.	'
NIE-BKO	Error Control Codes	Z,ZK	5
•	s the basic knowledge of security codes used in current systems for error detection and correction. It provides the necessary mathen	=	
=	es and codes for the correction of multiple errors, clusters of errors and whole syllables (bytes). Students will also learn how to imple rections for different types of transmissions (parallel, serial) when storing data in memory and when transmitting over telecommunica		tions and
NIE-BLO	Blockchain	Z,ZK	5
	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platform	,	1
· ·	secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places a		
relationship between	en blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the	students for imple	ementing or
NIE-BPS	supervising implementation of blockchain-based solutions in both academia and business.	Z.ZK	
	Wireless Computer Networks about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad		ticast and
	isms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowle		
	for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable	le tools.	
NIE-BVS	Embedded Security	Z,ZK	5
-	knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptography		
and software (in em	bedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources of computer systems.	for securing inter	nal functions
NIE-CPX	Complexity Theory	Z,ZK	5
-	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		-
	(in)tractability of difficult problems.	,	
NIE-DDW	Web Data Mining	Z,ZK	5
	rn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain		- 1
techniques for Web	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie in the field of social web and recommendation systems.	w of most recent d	evelopments
NIE-DIP	Diploma Thesis	Z	30
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
-	iced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing	,	- 1
channels. They lear	n basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that s	upport high availa	ability of both
	data and services, and safety in case of failures.		
NIE-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends	to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	the most fundame	ental notions
NIE-EHW	Embedded Hardware	Z,ZK	5
	basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the		1
•	from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,		
	of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NIE-EPC	Effective C++ programming	Z,ZK	5
	to use the modern features of contemporary versions of the C++ programming language for software development. The course focus	· -	
NIE-ESW	ciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor t Embedded Software	Z,ZK	5
	course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the ba	•	1
	code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up		1
	combined with artificial intelligence.		
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowle	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access	s time and memor	y complexity.
NIE-FME	They will be able to use the knowledge in design of applications that utilize pattern matching.	Z,ZK	5
	Formal Methods and Specifications o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some so	•	1
	basic properties of software.		
NIE-GAK	Graph theory and combinatorics	Z,ZK	5
The goal of the class	ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.	The emphasis wil	- 1
•	basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top	• .	,, , ,
coloring, Hamsey th	neory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory w of combinatorics on words, formal languages and bioinformatics.	пп ре атво аррпеа	i iii iiie iielas
NIE-GPU	GPU Architectures and Programming	Z,ZK	5
	nowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI	•	1
which is already a w	idespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical computational use of these hierarchical computational use of these hierarchical computations.	putational structui	res, students
	will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.		

NIE-HMI History of Mathematics and Informatics Z,ZK 3 The course focuses on selected topics from calculus, general algebra, number theory, numerical mathematics and logic - useful for today computer science The topics are selected for finding some relations between computer science and mathematical methods. Some examples of applications of mathematics to computer sciences will be showed. Side-Channel Analysis in Hardware This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get familiar with various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with higher-order attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage. Hardware Security The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer. NIF-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-KOP Combinatorial Optimization Z.ZK 6 The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems. Advanced Cryptology Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions. Multicore CPU Computing Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications. NIE-MKY Mathematics for Cryptology Z,ZK Studenti získají hlubší znalosti o algebraických postupech řešících nejdůležitější matematické problémy, na kterých je založena bezpečnost šifer. Zejména se jedná o problém řešení soustavy polynomiálních rovníc nad konečným tělesem, problém faktorizace velkých čísel a problém diskrétního logaritmu. Problém faktorizace bude speciálně řešen i na eliptických křivkách. Studenti se rovnež seznámí s moderními šifrovacími systémy založenými na počítání na mřížce. NIE-MPI Mathematics for Informatics Z,ZK 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-MPR Master Project Z 1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. The external supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/student/studijni/formulare). The completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester. NIE-MTI Modern Internet Technologies Z,ZK 5 Students learn advanced networking technologies and protocols for both local area networks and wide area networks. They get acquainted with routing techniques and transfer technologies of modern internet, including multimedia data transfer, with various types of network virtualization, and with last-mile security. Computational Intelligence Methods Students will understand the basic methods and techniques of computational intelligence, which are based on traditional artificial intelligence, are parallel in nature and are applicable to solving a wide range of problems. The subject is also devoted to modern neural networks and the ways in which they learn and neuroevolution. Students will learn how these methods work and how to apply them to problems related to data extraction, management, intelligence in games and optimisation, etc. Nonlinear Continuous Optimization and Numerical Methods NIF-NON 7.7K Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods to real-world problems. They will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They will learn to solve systems of linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement these algorithms sequentially as well as in parallel. **NIE-NSS** Normalized Software Systems ZK 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. User Interface Design 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. This course replaces MIE-MDW. Operating Systems and Systems Programming This course is focused on the design and implementation of the basic components that make up modern operating systems. This includes threads, processes, switching context, virtual memory, system calls, interrupts and interactions of SW and HW using drivers. Students will learn the theory of the concept of operating system architecture with emphasis on the kernel architecture. Within the course, they will gain practical experience with the development of a small but fully functional operating system. Parameterized Algorithms There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property

(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes. Advanced Database Systems Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines. This course is equivalent to the course MIE-PDB. NIE-PDL Practical Deep Learning This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing. NIE-PDP Parallel and Distributed Programming Z,ZK 21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Parallel computing systems are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course includes a semester project of practical programming in OpenMP and MPI for solving a particular nontrivial problem. **NIE-PIS** Advanced Information Systems Students learn the notion of business process logic and its formalization, with business process roles, business rules, and data processing, with the notion of service oriented company, enterprise services and service solution of business logic. They get acquainted with these notions also for the other types of ISs. They learn about agility and adaptivity and using of artificial intelligence methods for implementation of these ideas in ISs. They understand modern object-oriented methodologies for modelling of business processes, business rules, processed data, and enterprise ISs. They will get the rules and technologies for successful implementation of IS. NIE-PML Personalized Machine Learning Z.ZK Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities. NIE-REV Reverse Engineering Z,ZK 5 Students will learn fundamentals of reverse engineering of computer software (methods of executing and initializing programs, organization of executable files, work with third-party libraries). Special attention will be paid to C++. Students will also become familiar with the principles of debugging tools, disassemblers and obfuscation methods. Finally, the course will focus on code compression and decompression and executable file reconstruction. NIE-ROZ Pattern Recognition Z,ZK The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects. System Security and Forensics Students will be introduced to various aspects of system security (principles of endpoint security, principles of security policies, security models, authentication concepts). Students will also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis techniques, and the importance of memory or file system artifacts for attack analysis and detection). NIE-SCE1 Computer Engineering Seminar Master I 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 KČN laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each Computer Engineering Seminar Master II The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in KČN 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** Z.ZK 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). Digital Circuit Simulation and Verification Aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers today recent verification methods, too. **NIE-SWE** Semantic Web and Knowledge Graphs Z,ZK The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance. NIE-SYP Parsing and Compilers Z,ZK

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

NIE-TES	Systems Theory	Z,ZK	5
Today, humankin	d has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However		aging this
•	ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of m		0 0
aspects of the syst	ems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and alg	orithms that form t	he basis for
	the modeling and analysis of complex systems.		
NIE-TSP	Testing and Reliability	Z,ZK	5
Students will gain k	knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prej	oare a test set with	the help of
the intuitive path se	ensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with bu	ilt-in-self-test equi _l	pment. They
	will be able to compute, analyze, and control the reliability and availability of the designed circuits.		
NIE-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gain	n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	organizations. The	ey will get
acquainted with vir	tualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie	ently operate and o	ptimize the
performance par	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effecti	ve technology tod	ay for the
management of cor	nplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills ir	n the use of moder	n integration
	and development tools (Continuous integration and development).		
NIE-VPR	Research Project	Z	5
•	Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.		,
NIE-VSM	Selected statistical Methods	Z,ZK	7
Summary of probab	ility theory; Multivariate normal distribution; Entropy and its application to coding; Statistical tests: T-tests, goodness of fit tests, independ	dence test; Randor	n processes
	- stacionarity; Markov chains and limiting properties; Queuing theory		
NIE-VYC	Computability	Z,ZK	4
	Classical theory of recursive functions and effective computability.		'

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