Study plan

Name of study plan: Master programme, for the phase of study without specialisation, ver. for 2026 and higher

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department:
Garantor of the study branch: prof. Ing. Róbert Lórencz, CSc.
Program of study: Informatics
Type of study: Follow-up master full-time
Required credits: 62
Elective courses credits: 58
Sum of credits in the plan: 120
Note on the plan: Study plan valid for students enrolled from the 2026/2027 academic year

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Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 62
The role of the block: PP

Code of the group: NIE-PP.2026
Name of the group: Compulsory courses of master study program Informatics, version 2026, i English
Requirement credits in the group: In this group you have to gain at least 62 credits (at most 0)
Requirement courses in the group: In this group you have to complete at least 6 courses
Credits in the group: 62
Note on the group: Groups valid for study plans assigned to students from the 2026/2027 academic year

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-DIP	**Diploma Thesis** *Zdeněk Muzikář* ***Zdeněk Muzikář*** *Zdeněk Muzikář (Gar.)*	Z	30	270ZP	L,Z	PP
NIE-TIN	**Information Theory** ***Pavel Hrabák***	Z,ZK	6	2P+2C	L	PP
NIE-ICC	**Introduction to Computational Complexity** ***Dušan Knop***	Z,ZK	6	2P+1C+1L	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

Characteristics of the courses of this group of Study Plan: Code=NIE-PP.2026 Name=Compulsory courses of master study program Informatics, version 2026, i English

NIE-DIP	Diploma Thesis	Z	30
NIE-TIN	Information Theory	Z,ZK	6

The course focuses on the mathematical description of a random message source, its coding and transmission of the source through a noisy channel. The coding problem is addressed probabilistically, the relation of the mean length of the optimal code with the entropy and entropy rate of the random source is emphasized. In the case of the noisy channel we focus on the set of typical sequences and its appropriate coding by self-correcting codes. The course includes a reminder of necessary concepts such as conditional distributions, goodness-of-fit and independence tests, and an introduction to random chains.

NIE-ICC	Introduction to Computational Complexity	Z,ZK	6

On-site lectures and tutorials supported by an e-learning platform with materials, streamed and recorded lectures, and proseminars. Emphasis is placed on active student engagement and discussion.

NIE-MPR	Master Project	Z	7

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

NIE-MPI	Mathematics for Informatics	Z,ZK	7

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

NIE-PDP	Parallel and Distributed Programming	Z,ZK	6

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

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

Code of the group: NIE-PRO.26
Name of the group: Choose (so far as optional) profiling subjects for the intended specialization
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: Choose (so far as optional) profiling subjects for the intended specialization

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** *Jiří Buček, Róbert Lórencz* ***Jiří Buček*** *Róbert Lórencz (Gar.)*	Z,ZK	5	2P+2C	Z	VO
NIE-AOS	**Advanced Operating Systems** ***Petr Zemánek***	Z,ZK	5	2P+1C	Z	VO
NIE-APT	**Advanced Program Testing** *Pierre Donat-Bouillud* ***Pierre Donat-Bouillud*** *Pierre Donat-Bouillud (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-AIB	**Algorithms of Information Security** *Martin Jureček* ***Martin Jureček*** *Martin Jureček (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-GEN	**Code Generators** *Petr Máj* ***Petr Máj*** *Jan Janoušek (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-CPX.26	**Complexity Theory** ***Dušan Knop***	Z,ZK	6	3P+1C	Z	VO
NIE-KOD	**Data Compression** *Jan Holub* ***Jan Holub*** *Jan Holub (Gar.)*	Z,ZK	5	2P+1C	L	VO
NIE-DSV	**Distributed Systems and Computing** *Pavel Tvrdík, Peter Macejko* ***Peter Macejko*** *Pavel Tvrdík (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-EVY	**Efficient Text Pattern Matching** *Jan Holub* ***Jan Holub*** *Jan Holub (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-GPU	**GPU Architectures and Programming** *Ivan Šimeček* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	L	VO
NIE-GAK.26	**Graph theory and combinatorics** ***Tomáš Valla***	Z,ZK	6	2P+2C	L	VO
NIE-HWB	**Hardware Security** *Jiří Buček* ***Jiří Buček*** *Jiří Buček (Gar.)*	Z,ZK	5	2P+2C	L	VO
NIE-LOM	**Linear Optimization and Methods** *Dušan Knop* ***Dušan Knop*** *Dušan Knop (Gar.)*	Z,ZK	5	2P+0S+1C	Z	VO
ANIE-MLM	**Machine Learning Methods** ***Daniel Vašata***	Z,ZK	5	2P+1C		VO
NIE-MKY.26	**Mathematics for Cryptology** ***Róbert Lórencz***	Z,ZK	7	3P+2C	L	VO
NIE-MPS	**Modern Computer Networks** ***Jan Fesl***	Z,ZK	5	2P+2C	Z	VO
NIE-MCC	**Multicore CPU Computing** *Daniel Langr, Ivan Šimeček* ***Ivan Šimeček*** *Ivan Šimeček (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-SIB	**Network Security** *Tomáš Zahradnický, Jiří Dostál, Simona Fornůsek, Gramoz Cubreli* ***Simona Fornůsek*** *Simona Fornůsek (Gar.)*	Z,ZK	5	2P+1C	L	VO
NIE-PAM	**Parameterized Algorithms** *Ondřej Suchý* ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	Z,ZK	4	2P+1C	L	VO
NIE-SYP	**Parsing and Compilers** *Jan Janoušek* ***Jan Janoušek*** *Jan Janoušek (Gar.)*	Z,ZK	5	2P+1C	Z	VO
NIE-REV	**Reverse Engineering** *Josef Kokeš* ***Josef Kokeš*** *Josef Kokeš (Gar.)*	Z,ZK	5	1P+2C	Z	VO

NIE-RUN	**Runtime Systems** *Filip Křikava, Filip Říha* ***Filip Křikava*** *Filip Křikava (Gar.)*	Z,ZK	5	2P+1C	L	VO
NIE-APR	**Selected Methods for Program Analysis** ***Filip Křikava***	Z,ZK	5	2P+1C	Z	VO
NIE-SEM	**Semantics of Programming Languages** ***Tomáš Jakl***	Z,ZK	5	2P+1C	Z	VO
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	VO
NIE-VCC	**Virtualization and Cloud Computing** *Tomáš Vondra* ***Tomáš Vondra*** *Tomáš Vondra (Gar.)*	Z,ZK	5	2P+1C	L	VO

Characteristics of the courses of this group of Study Plan: Code=NIE-PRO.26 Name=Choose (so far as optional) profiling subjects for the intended specialization

NIE-KRY	Advanced Cryptology	Z,ZK	5

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

NIE-AOS	Advanced Operating Systems	Z,ZK	5

The course focuses on system programming in Unix-like operating systems, with an emphasis on OS kernel development and advanced technologies for Unix system administration. Students will learn about the architecture and data structures of the OS kernel, process and memory management, the internal architecture of modern file systems, implementations of device control and network communication methods, kernel and OS booting techniques, as well as kernel debugging using dynamic instrumentation. They will also gain knowledge of kernel development and modification processes, ensuring kernel portability, and the use of containerization and virtualization technologies. Additionally, students will become familiar with the specifics of kernel implementation for embedded systems and real-time systems. Theoretical and general principles will be demonstrated primarily using the Linux kernel. The tutorials will focus on developing Linux kernel modules and using tools for managing the discussed technologies.

NIE-APT	Advanced Program Testing	Z,ZK	5

Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.

NIE-AIB	Algorithms of Information Security	Z,ZK	5

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.

NIE-GEN	Code Generators	Z,ZK	5

Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of systems programming. This primarily involves understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming. Students will become familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.

NIE-CPX.26	Complexity Theory	Z,ZK	6

Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.

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-DSV	Distributed Systems and Computing	Z,ZK	5

Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of 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-EVY	Efficient Text Pattern Matching	Z,ZK	5

Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access time and memory complexity. They will be able to use the knowledge in design of applications that utilize pattern matching.

NIE-GPU	GPU Architectures and Programming	Z,ZK	5

Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the 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.

NIE-GAK.26	Graph theory and combinatorics	Z,ZK	6

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-HWB	Hardware Security	Z,ZK	5

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

NIE-LOM	Linear Optimization and Methods	Z,ZK	5

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

ANIE-MLM	Machine Learning Methods	Z,ZK	5
The course introduces students to machine learning methods applicable within their specializations in the follow-up Applied Informatics program. These principles and competencies are not part of the common undergraduate curriculum and are typically taught only in specializations focused on artificial intelligence. The aim is to understand the theoretical foundations and to gain practical experience in applying models suitable for regression and classification tasks within supervised learning, including kernel methods and neural networks. In unsupervised learning, students will become familiar primarily with clustering models and principal component analysis. The course also covers model evaluation techniques and fundamental methods for data preprocessing. Practical exercises involve data analysis and model implementation using the Python libraries pandas, scikit-learn, and PyTorch.			
NIE-MKY.26	Mathematics for Cryptology	Z,ZK	7
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course focuses on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete logarithm. The problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.			
NIE-MPS	Modern Computer Networks	Z,ZK	5
The course is divided into two complementary parts modern network technologies and computer network security. The first part is devoted to explaining the principles of modern network technologies and communication protocols that enable high throughput, low latency, and fault tolerance. The lectures also cover the principles of modern software-defined networks, which are gradually replacing traditional networks. The first part concludes with an explanation of protocols and technologies designed for real-time video and voice transmission. In the second part, the basic principles and technologies that support and enhance computer network security are introduced. Subsequent lectures focus on explaining the principles of well-known network attacks in local area networks and on the Internet. Finally, modern systems for detecting and mitigating network attacks are presented, including systems for sharing information that make it possible to prevent network attacks proactively. Students gain hands-on experience with these concepts in the network laboratory.			
NIE-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.			
NIE-SIB	Network Security	Z,ZK	5
The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically 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-PAM	Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will present a plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not exist. We will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.			
NIE-SYP	Parsing and Compilers	Z,ZK	5
The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.			
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-RUN	Runtime Systems	Z,ZK	5
As the abstraction level of programming languages steadily rises, modern programs require greater and greater support during their runtime. This course introduces students to various aspects of the runtime support, such as runtime-effective program description, memory management support and garbage collection, just-in-time compilation, and interoperability with other languages and systems.			
NIE-APR	Selected Methods for Program Analysis	Z,ZK	5
This course introduces you to program analysisthe automated reasoning about the behavior of computer programs. We will cover both static and dynamic analysis. In static analysis, we explore the art of reasoning about programs without executing them, including techniques for program understanding, optimization, and error detection. In dynamic analysis, we examine individual program executions within specific environments and inputs.			
NIE-SEM	Semantics of Programming Languages	Z,ZK	5
The aim of the course is to introduce students to the basics of programming language semantics, which forms the foundation for the study and implementation of programming languages. These techniques are also important for program verification, the implementation of optimizations, and the general design of programming languages. The emphasis will be on comparing operational and denotational semantics. The techniques used are also applicable when analysing languages specified only by an operational semantics. The course will enable students to acquire the skills needed to implement language constructs, regardless of whether their description comes from theoretical or engineering sources in the literature.			
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-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development).			

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

Code of the group: NIE-V.26

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: Study plan valid for students enrolled from the 2026/2027 academic year

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
FIT-BIP	**Blended Intensive Programme** ***Zdeněk Muzikář*** *Zdeněk Muzikář (Gar.)*	Z	3		Z,L	v
NIE-BLO	**Blockchain** *Josef Gattermayer, Jakub Růžička, Marek Bielik* ***Josef Gattermayer*** *Josef Gattermayer (Gar.)*	Z,ZK	5	1P+2C	Z	v
NIE-VYC	**Computability** *Jan Starý* ***Jan Starý*** *Jan Starý (Gar.)*	Z,ZK	4	2P+2C	L	v
NIE-ARI	**Computer arithmetic** *Pavel Kubalík* ***Pavel Kubalík*** *Pavel Kubalík (Gar.)*	Z,ZK	4	2P+1C	Z,L	v
NIE-SCE1	**Computer Engineering Seminar Master I** *Hana Kubátová, Miroslav Skrbek* ***Hana Kubátová*** *Hana Kubátová (Gar.)*	Z	4	2C	Z	v
NIE-SCE2	**Computer Engineering Seminar Master II** *Hana Kubátová* ***Hana Kubátová*** *Hana Kubátová (Gar.)*	Z	4	2C	L	v
NI-DSW	**Design Sprint** *Ondřej Brém, Michal Manda* ***Michal Manda*** *Ondřej Brém (Gar.)*	Z	2	30B	Z	v
ANIE-SIM	**Digital Circuit Simulation and Verification** ***Martin Kohlík***	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
ANIE-EHW	**Embedded Hardware** ***Jan Schmidt***	Z,ZK	5	2P+2C	L	v
ANIE-BVS	**Embedded Security** ***Martin Novotný***	Z,ZK	5	2P+2C	L	v
ANIE-ESW	**Embedded Software** ***Miroslav Skrbek***	Z,ZK	5	2P+2C	Z	v
ANIE-BKO	**Error Control Coding** ***Pavel Kubalík***	Z,ZK	5	2P+1C	L	v
NI-GLR	**Games and reinforcement learning** ***Juan Pablo Maldonado Lopez***	Z,ZK	4	2P+2C	L	v
FITE-GIA	**Global issues and artificial intelligence** ***Tomáš Evan***	ZK	4	2P+1C	Z,L	v
FITE-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*** *Alena Šolcová (Gar.)*	Z,ZK	3	2P+1C	Z	v
NIE-DVG	**Introduction to Discrete and Computational Geometry** *Maria Saumell Mendiola* ***Maria Saumell Mendiola*** *Maria Saumell Mendiola (Gar.)*	Z,ZK	5	2P+1C	L	v
FITE-EHD	**Introduction to European Economic History** *Tomáš Evan* ***Tomáš Evan*** *Tomáš Evan (Gar.)*	Z,ZK	3	2P+1C	L	v
NIE-AM2	**Middleware Architectures 2** *Milan Dojčinovski* ***Milan Dojčinovski*** *Milan Dojčinovski (Gar.)*	Z,ZK	5	2P+1C	L	v
ANIE-COM	**Network Communication** *Tomáš Čejka* ***Tomáš Čejka*** *Tomáš Čejka (Gar.)*	Z,ZK	5	2P+1C		v
NIE-OSY	**Operating Systems and Systems Programming** *Petr Zemánek* ***Petr Zemánek*** *Petr Zemánek (Gar.)*	Z,ZK	5	2P+1C	Z	v
NIE-ROZ	**Pattern Recognition** *Michal Haindl* ***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** *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	v
FIT-ACM1	**Programming Practices 1** ***Tomáš Valla*** *Tomáš Valla (Gar.)*	KZ	5	4C	L	v
FIT-ACM2	**Programming Practices 2** ***Tomáš Valla*** *Ondřej Suchý (Gar.)*	KZ	5	4C	Z	v
FIT-ACM3	**Programming Practices 3** ***Tomáš Valla*** *Ondřej Suchý (Gar.)*	KZ	5	4C	L	v
FIT-ACM4	**Programming Practices 4** ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	KZ	5	4C	Z	v

FIT-ACM5	**Programming Practices 5** ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	KZ	5	4C	L	v
FIT-ACM6	**Programming Practices 6** ***Ondřej Suchý*** *Ondřej Suchý (Gar.)*	KZ	5	4C	L	v
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	v
NIE-HSC	**Side-Channel Analysis in Hardware** *Vojtěch Miškovský, Petr Socha* ***Vojtěch Miškovský*** *Vojtěch Miškovský (Gar.)*	Z,ZK	4	2P+2C	Z	v
ANIE-TSP	**Testing and Reliability** ***Martin Daňhel***	Z,ZK	5	2P+2C	Z	v
NIE-DDW	**Web Data Mining** *Milan Dojčinovski* ***Milan Dojčinovski*** *Milan Dojčinovski (Gar.)*	Z,ZK	5	2P+1C	L	v
NIE-BPS	**Wireless Computer Networks** *Alexandru Moucha* ***Alexandru Moucha*** *Alexandru Moucha (Gar.)*	Z,ZK	4	2P+1C	L	v
FITE-SEP	**World Economy and Business** *Tomáš Evan* ***Tomáš Evan*** *Tomáš Evan (Gar.)*	Z,ZK	4	2P+2C	Z	v
NIE-SEP	**World Economy and Business** *Tomáš Evan* ***Tomáš Evan*** *Tomáš Evan (Gar.)*	Z,ZK	4	2P+1C	Z	v

Characteristics of the courses of this group of Study Plan: Code=NIE-V.26 Name=Purely elective master's courses

FIT-BIP	Blended Intensive Programme	Z	3
NIE-BLO	Blockchain	Z,ZK	5
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-VYC	Computability	Z,ZK	4
Classical theory of recursive functions and effective computability.			
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-SCE1	Computer Engineering Seminar Master I	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 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-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 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.			
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 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).			
ANIE-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
The 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 recent verification methods, too.			
NIE-EPC	Effective C++ programming	Z,ZK	5
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.			
ANIE-EHW	Embedded Hardware	Z,ZK	5
The course provides a comprehensive overview of fundamental techniques and theoretical principles underlying the design of digital systems at both small and large scales. It establishes the conceptual and practical foundation for the development of advanced embedded systems that exploit functional specialization to achieve efficient hardware implementations and computational acceleration. Topics include high-speed system design methodologies, standard internal communication protocols, and the utilization of inherent computational parallelism within specialized hardware structures and system architectures.			
ANIE-BVS	Embedded Security	Z,ZK	5
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.			
ANIE-ESW	Embedded Software	Z,ZK	5
The course introduces students to the principles and distinctive features of software development for embedded systems. It leads students from the basics of programming in C and code optimization through key topics such as reliable software design, embedded operating systems, and signal processing, culminating in advanced methods that integrate embedded software development with artificial intelligence.			
ANIE-BKO	Error Control Coding	Z,ZK	5
The course extends the basic knowledge of error-control codes used in modern systems for error detection and correction. It presents the necessary mathematical theory and the principles of linear and cyclic codes, as well as codes for correcting multiple errors, burst errors, and whole symbols (bytes). Students will also learn how to implement these detection and correction techniques for different types of transmission (parallel and serial), when storing data in memories and when transmitting it over telecommunication channels.			
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 intelligence. This course is intended to give you both theoretical and practical background so you can participate in related research activities. Presented in English.			

FITE-GIA	Global issues and artificial intelligence	ZK	4
This course explores the transformative role of Artificial Intelligence (AI) in addressing and shaping the most pressing global challenges of the 21st century. Students will critically analyse AI as both a powerful tool to help solve complex problems (such as resource optimization, arms proliferation and healthcare) and a source of new systemic risks involving ethics or geopolitical power shifts. Seminars help to improve on the knowledge in the form of discussions based on individual readings and resource interpretation.			
FITE-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 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.			
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 the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component.			
FITE-EHD	Introduction to European Economic History	Z,ZK	3
The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy 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.			
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, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.			
ANIE-COM	Network Communication	Z,ZK	5
The course focuses on the technical aspects of communication between devices and systems. During the semester, topics will be presented ranging from physical layers and communication media to communication protocols and traffic monitoring. Upon completion, students will gain an understanding of the technical limitations and capabilities of communication tools that can be applied in the design and development of real hardware or software systems.			
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, 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.			
NIE-ROZ	Pattern Recognition	Z,ZK	5
The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.			
NIE-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 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.			
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 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.			
NIE-PDL	Practical Deep Learning	KZ	5
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning 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.			
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
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM4	Programming Practices 4	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM5	Programming Practices 5	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
FIT-ACM6	Programming Practices 6	KZ	5
This is a selective course for preparing talented student for representation in international programming contests.			
NIE-VPR	Research Project	Z	5
1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. External Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR, MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of the department responsible for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.			
NIE-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-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical 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.			

ANIE-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-DDW	Web Data Mining	Z,ZK	5
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems.			
NIE-BPS	Wireless Computer Networks	Z,ZK	4
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.			
FITE-SEP	World Economy and Business	Z,ZK	4
The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and 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-SEP	World Economy and Business	Z,ZK	4
The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
ANIE-BKO	Error Control Coding	Z,ZK	5
The course extends the basic knowledge of error-control codes used in modern systems for error detection and correction. It presents the necessary mathematical theory and the principles of linear and cyclic codes, as well as codes for correcting multiple errors, burst errors, and whole symbols (bytes). Students will also learn how to implement these detection and correction techniques for different types of transmission (parallel and serial), when storing data in memories and when transmitting it over telecommunication channels.			
ANIE-BVS	Embedded Security	Z,ZK	5
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.			
ANIE-COM	Network Communication	Z,ZK	5
The course focuses on the technical aspects of communication between devices and systems. During the semester, topics will be presented ranging from physical layers and communication media to communication protocols and traffic monitoring. Upon completion, students will gain an understanding of the technical limitations and capabilities of communication tools that can be applied in the design and development of real hardware or software systems.			
ANIE-EHW	Embedded Hardware	Z,ZK	5
The course provides a comprehensive overview of fundamental techniques and theoretical principles underlying the design of digital systems at both small and large scales. It establishes the conceptual and practical foundation for the development of advanced embedded systems that exploit functional specialization to achieve efficient hardware implementations and computational acceleration. Topics include high-speed system design methodologies, standard internal communication protocols, and the utilization of inherent computational parallelism within specialized hardware structures and system architectures.			
ANIE-ESW	Embedded Software	Z,ZK	5
The course introduces students to the principles and distinctive features of software development for embedded systems. It leads students from the basics of programming in C and code optimization through key topics such as reliable software design, embedded operating systems, and signal processing, culminating in advanced methods that integrate embedded software development with artificial intelligence.			
ANIE-MLM	Machine Learning Methods	Z,ZK	5
The course introduces students to machine learning methods applicable within their specializations in the follow-up Applied Informatics program. These principles and competencies are not part of the common undergraduate curriculum and are typically taught only in specializations focused on artificial intelligence. The aim is to understand the theoretical foundations and to gain practical experience in applying models suitable for regression and classification tasks within supervised learning, including kernel methods and neural networks. In unsupervised learning, students will become familiar primarily with clustering models and principal component analysis. The course also covers model evaluation techniques and fundamental methods for data preprocessing. Practical exercises involve data analysis and model implementation using the Python libraries pandas, scikit-learn, and PyTorch.			
ANIE-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
The 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 recent verification methods, too.			
ANIE-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.			
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
This is a selective course for preparing talented student for representation in international programming contests.			

FIT-ACM4	Programming Practices 4	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM5	Programming Practices 5	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-ACM6	Programming Practices 6	KZ	5
	This is a selective course for preparing talented student for representation in international programming contests.		
FIT-BIP	Blended Intensive Programme	Z	3
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 economy 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-GIA	Global issues and artificial intelligence	ZK	4
	This course explores the transformative role of Artificial Intelligence (AI) in addressing and shaping the most pressing global challenges of the 21st century. Students will critically analyse AI as both a powerful tool to help solve complex problems (such as resource optimization, arms proliferation and healthcare) and a source of new systemic risks involving ethics or geopolitical power shifts. Seminars help to improve on the knowledge in the form of discussions based on individual readings and resource interpretation.		
FITE-GRI	Grid Computing	Z,ZK	5
	Grid computing and gain knowledge about the world-wide network and computing infrastructure.		
FITE-SEP	World Economy and Business	Z,ZK	4
	The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and 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.		
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 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-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 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-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 intelligence. This course is intended to give you both theoretical and practical background so you can participate in related research activities. Presented in English.		
NIE-AIB	Algorithms of Information Security	Z,ZK	5
	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.		
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, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.		
NIE-AOS	Advanced Operating Systems	Z,ZK	5
	The course focuses on system programming in Unix-like operating systems, with an emphasis on OS kernel development and advanced technologies for Unix system administration. Students will learn about the architecture and data structures of the OS kernel, process and memory management, the internal architecture of modern file systems, implementations of device control and network communication methods, kernel and OS booting techniques, as well as kernel debugging using dynamic instrumentation. They will also gain knowledge of kernel development and modification processes, ensuring kernel portability, and the use of containerization and virtualization technologies. Additionally, students will become familiar with the specifics of kernel implementation for embedded systems and real-time systems. Theoretical and general principles will be demonstrated primarily using the Linux kernel. The tutorials will focus on developing Linux kernel modules and using tools for managing the discussed technologies.		
NIE-APR	Selected Methods for Program Analysis	Z,ZK	5
	This course introduces you to program analysisthe automated reasoning about the behavior of computer programs. We will cover both static and dynamic analysis. In static analysis, we explore the art of reasoning about programs without executing them, including techniques for program understanding, optimization, and error detection. In dynamic analysis, we examine individual program executions within specific environments and inputs.		
NIE-APT	Advanced Program Testing	Z,ZK	5
	Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.		
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-BLO	Blockchain	Z,ZK	5
	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	Z,ZK	4
	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-CPX.26	Complexity Theory	Z,ZK	6
	Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems.		

NIE-DDW	Web Data Mining	Z,ZK	5
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems.			
NIE-DIP	Diploma Thesis	Z	30
NIE-DSV	Distributed Systems and Computing	Z,ZK	5
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of 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-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 the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component.			
NIE-EPC	Effective C++ programming	Z,ZK	5
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.			
NIE-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both access time and memory complexity. They will be able to use the knowledge in design of applications that utilize pattern matching.			
NIE-GAK.26	Graph theory and combinatorics	Z,ZK	6
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-GEN	Code Generators	Z,ZK	5
Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of systems programming. This primarily involves understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming. Students will become familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.			
NIE-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the 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.			
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.			
NIE-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical 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.			
NIE-HWB	Hardware Security	Z,ZK	5
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards against abuse of the system using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students will gain knowledge about the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the computer.			
NIE-ICC	Introduction to Computational Complexity	Z,ZK	6
On-site lectures and tutorials supported by an e-learning platform with materials, streamed and recorded lectures, and proseminars. Emphasis is placed on active student engagement and discussion.			
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-KRY	Advanced Cryptology	Z,ZK	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions.			
NIE-LOM	Linear Optimization and Methods	Z,ZK	5
Students will gain an overview of applications of optimization methods in computer science, economics and industrial practice. They will be introduced to the practical importance of linear and integer programming. They will be able to work with optimization software and to master the languages used in its programming. They will be able to formalise optimisation problems in the areas of computer science (e.g. task allocation to processors, network flow analysis), resource distribution and allocation (traffic problems, business traveller problem, etc.). Gain an overview of computational complexity issues in optimization. Gain a good understanding of linear programming algorithms and selected integer linear programming algorithms.			
NIE-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memory, which are today the most common computing nodes of powerful computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the decrease in computing power due to the widening performance gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.			
NIE-MKY.26	Mathematics for Cryptology	Z,ZK	7
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course focuses on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete logarithm. The problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.			
NIE-MPI	Mathematics for Informatics	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-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-MPS	Modern Computer Networks	Z,ZK	5

The course is divided into two complementary parts modern network technologies and computer network security. The first part is devoted to explaining the principles of modern network technologies and communication protocols that enable high throughput, low latency, and fault tolerance. The lectures also cover the principles of modern software-defined networks, which are gradually replacing traditional networks. The first part concludes with an explanation of protocols and technologies designed for real-time video and voice transmission. In the second part, the basic principles and technologies that support and enhance computer network security are introduced. Subsequent lectures focus on explaining the principles of well-known network attacks in local area networks and on the Internet. Finally, modern systems for detecting and mitigating network attacks are presented, including systems for sharing information that make it possible to prevent network attacks proactively. Students gain hands-on experience with these concepts in the network laboratory.

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, 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.

NIE-PAM	Parameterized Algorithms	Z,ZK	4

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

NIE-PDL	Practical Deep Learning	KZ	5

This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing.

NIE-PDP	Parallel and Distributed Programming	Z,ZK	6

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

NIE-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 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	5

The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.

NIE-RUN	Runtime Systems	Z,ZK	5

As the abstraction level of programming languages steadily rises, modern programs require greater and greater support during their runtime. This course introduces students to various aspects of the runtime support, such as runtime-effective program description, memory management support and garbage collection, just-in-time compilation, and interoperability with other languages and systems.

NIE-SBF	System Security and Forensics	Z,ZK	5

Students will be introduced to various aspects of system security (principles of endpoint security, principles of security policies, security models, authentication concepts). Students will also learn about forensic analysis as a tool for investigating security incidents (techniques used by malicious software or attackers, forensic analysis techniques, and the importance of memory or file system artifacts for attack analysis and detection).

NIE-SCE1	Computer Engineering Seminar Master I	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 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-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 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-SEM	Semantics of Programming Languages	Z,ZK	5

The aim of the course is to introduce students to the basics of programming language semantics, which forms the foundation for the study and implementation of programming languages. These techniques are also important for program verification, the implementation of optimizations, and the general design of programming languages. The emphasis will be on comparing

	operational and denotational semantics. The techniques used are also applicable when analysing languages specified only by an operational semantics. The course will enable students to acquire the skills needed to implement language constructs, regardless of whether their description comes from theoretical or engineering sources in the literature.		
NIE-SEP	World Economy and Business	Z,ZK	4
	The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.		
NIE-SIB	Network Security	Z,ZK	5
	The students will gain theoretical and practical knowledge and experience in the area of current security threats in computer networks, specifically about detection and defense. The course explains basic pricipals of security monitoring, packet-based and flow-based analysis, in order to detect anomalies and suspicious network traffic. The course focuses on explanation and practical examples of various mechanisms of securing network infrastructure and detection in real time. The course covers general principals of handling detected security events (i.e. incident handling and incident response).		
NIE-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
	The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance.		
NIE-SYP	Parsing and Compilers	Z,ZK	5
	The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.		
NIE-TIN	Information Theory	Z,ZK	6
	The course focuses on the mathematical description of a random message source, its coding and transmission of the source through a noisy channel. The coding problem is addressed probabilistically, the relation of the mean length of the optimal code with the entropy and entropy rate of the random source is emphasized. In the case of the noisy channel we focus on the set of typical sequences and its appropriate coding by self-correcting codes. The course includes a reminder of necessary concepts such as conditional distributions, goodness-of-fit and independence tests, and an introduction to random chains.		
NIE-VCC	Virtualization and Cloud Computing	Z,ZK	5
	Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development).		
NIE-VPR	Research Project	Z	5
	1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. External Master these (MT) supervisor fills his/her assessment into the paper "Form to award assessment by an external Final theses (FT) supervisor" (for the courses BIE-BAP, MIE-MPR, MIE-DIP). Students, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the assessment to the IS based on the confirmation of the external MT supervisor. In the case the FT opponent is external as well, the assessment will be registered to the IS by the head of the department responsible for the topic of the MT. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.		
NIE-VYC	Computability	Z,ZK	4
	Classical theory of recursive functions and effective computability.		

For updated information see http://bilakniha.cvut.cz/en/FF.html
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