### Study plan

# Name of study plan: Master specialization System Programming, in Czech, version from 2023

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch: Program of study: Informatika

Type of study: Follow-up master full-time

Required credits: 98

Elective courses credits: 22 Sum of credits in the plan: 120

Note on the plan: Garant: doc. Ing. Jan Janoušek, Ph.D., email: jan.janousek@fit.cvut.cz

Name of the block: Compulsory courses in the program

Minimal number of credits of the block: 63

The role of the block: PP

Code of the group: NI-PP.2020

Name of the group: Compulsory Courses of Master Study Program, Version 2020, in Czech

Requirement credits in the group: In this group you have to gain 63 credits

Requirement courses in the group: In this group you have to complete 6 courses

Credits in the group: 63 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-KOP	Combinatorial Optimization Jan Schmidt, Petr Fiser Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	6	2P+2C	Z	PP
NI-DIP	Diploma Project Zden k Muziká Zden k Muziká Zden k Muziká (Gar.)	Z	30		L,Z	PP
NI-MPR	Master Project Zden k Muziká	Z	7		Z,L	PP
NI-MPI	Mathematics for Informatics Št pán Starosta, Jan Sp vák Št pán Starosta Št pán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NI-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík (Gar.)	Z,ZK	6	2P+2C	L	PP
NI-VSM	Selected statistical Methods Jitka Hrabáková, Petr Novák, Daniel Vašata, Ivo Petr, Pavel Hrabák, Jana Vacková Pavel Hrabák Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

### Characteristics of the courses of this group of Study Plan: Code=NI-PP.2020 Name=Compulsory Courses of Master Study Program, Version 2020, in Czech

NI-KOP	Combinatorial Optimization	Z,ZK	6			
The students will gain I	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.					
NI-DIP	Diploma Project	Z	30			
NI-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. 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.

NI-MPI Mathematics for Informatics Z,ZK 7

The course comprises topics from general algebra with focus 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 demonstration of applications in computer science. The course focuses on clear presentation and argumentation.

NI-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.

NI-VSM Selected statistical Methods

Z,ZK

**7** 

The course leads the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with multivariate normal distribution, application of entropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random processes with focus on Markov chains. The high point of the course is the Queuing theory and its application in networks.

Name of the block: Povinné p edm ty specializace

Minimal number of credits of the block: 35

The role of the block: PS

Code of the group: NI-PS-SP.23

Name of the group: Compulsory Courses of Master Specialization System Programming, v.2023, in Czech

Requirement credits in the group: In this group you have to gain 35 credits

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

Credits in the group: 35

Note on the	group.					
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-GEN	Code Generators Petr Máj, Jan Janoušek <b>Petr Máj</b> Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-OSY	Operating Systems and Systems Programming Petr Zemánek, Tomáš Martinec Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-APT	Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-RUN	Runtime Systems Filip K ikava, Michal Vlasák <b>Filip K ikava</b> Michal Vlasák (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-SYP	Parsing and Compilers  Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	L	PS

## Characteristics of the courses of this group of Study Plan: Code=NI-PS-SP.23 Name=Compulsory Courses of Master Specialization System Programming, v.2023, in Czech

NI-EPC	Effective C++ programming	Z,ZK	5
Students learn how to u	se the modern features of contemporary versions of the C++ programming language for software development. The course fo	ocuses on progra	mming effectivity
and efficiency in the for	n of writing maintainable and portable source code and creating correct programs with low memory and processor time requ	irements.	

 NI-GEN
 Code Generators
 Z,ZK
 5

 NI-OSY
 Operating Systems and Systems Programming
 Z,ZK
 5

The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel data structures. Key topics are: process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The course also addresses kernel development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. Specifics of kernel architecture in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, students will work on projects focused on development of LINUX kernel modules.

NI-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.

NI-RUN Runtime Systems

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.

NI-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.

NI-APR | Selected Methods for Program Analysis | Z,ZK | 5 |
Program analysis studies program behavior with the aim of code optimization and error detection. Students will learn static program analysis, which approximates program behavior without the need to actually run the program, as well as dynamic program analysis which analyse programs at runtime. Students will be introduced to the common techniques and algorithms and use them on some classical problems.

Name of the block: Elective courses

Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NI-V.2021

Name of the group: Purely Elective Master Courses, Version 2021

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

Credits in the group: 0

Note on the group:

In addition to the courses listed here, you can enroll as an elective any course that is offered within your study program and form of study that you did not enroll as a compulsory subject in the program/branch/specialization or a compulsory elective course. Courses of this group that a student has completed in the backglor study at CTLL counset by re-completed.

has completed in the bachelor study at CTU cannot be re-completed. Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their Code Completion Credits Semester Scope Role members) Tutors, authors and guarantors (gar.) AlgorithmicTheories of Games NI-ATH Z,ZK 4 2P+2C L ٧ Dusan Knop, Tomás Valla Tomás Valla Tomás Valla (Gar.) Algorithms and Graphs 2 BI-AG2.21 Z.ZK 5 2P+2C L Ond ej Suchý, Radek Hušek, Michal Opler Ond ej Suchý Ond ej Suchý **Applied Functional Programming** NI-AFP ΚZ 5 2P+1C L Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl Architecture of computer games Ζ NI-APH Z.ZK 4 2P+1C Adam Vesecký Adam Vesecký Adam Vesecký (Gar.) **Architectures of Computer Systems** BI-APS.21 5 2P+2C Ζ Z,ZK Pavel Tvrdík, Michal Štepanovský Michal Štepanovský Pavel Tvrdík (Gar.) **Wireless Computer Networks** NI-BPS 4 2P+1C L Z,ZK Alexandru Moucha Alexandru Moucha Alexandru Moucha (Gar.) **Secure Code** BI-BEK.21 Z,ZK 5 2P+2C ı Josef Kokeš, Viktor Fischer Róbert Lórencz Josef Kokeš (Gar.) **Blender BI-BLE** 4 2P+2C L Z,ZK V Lukáš Ba inka Lukáš Ba inka Lukáš Ba inka (Gar.) Blockchain NIE-BLO Z,ZK 5 1P+2C Ζ Róbert Lórencz, Jakub R ži ka, Josef Gattermayer, Marek Bielik Josef Gattermayer Róbert Lórencz (Gar.) Capture The Flag NI-CTF K7 4 3C Ζ Ji í Dostál **Game Design** 2P+1C NI-DPH Z,ZK 5 L ٧ Adam Vesecký Adam Vesecký Adam Vesecký (Gar.) **Design Sprint** Ζ 2 Ζ NI-DSW 30B Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.) **Public Services Design** NI-PSD ΚZ 4 1P+2C Ond ej Brém, David Pešek David Pešek (Gar.) Digital drawing Denisa S vová, Eliška Novotná **Denisa S vová** Denisa S vová (Gar.) NI-DID Ζ 2 4C Z,L NI-DZO Z,ZK 4 2P+1C L V **Digital Image Processing Distributed Data Mining** NI-DDM ΚZ 4 3C L V Tomáš Borovi ka **Efficient Preprocessing and Parameterized Algorithms** NI-PAM Z.ZK 4 2P+1C L Ond ej Suchý Ond ej Suchý (Gar.) Ethical Hacking BI-EHA.21 Z,ZK 5 2P+2C L Ji í Dostál, Tomáš Kiezler, Martin Kolárik, Martin Šutovský **Ji í Dostál** Ji í Dostál (Gar.) **Experimental Project Course** NI-ESC L ΚZ 8 0P+30R+52C ٧ Jan Matoušek, Ond ej Brém, Jitka Aslan **Ond ej Brém** Ond ej Brém (Gar.) **Financial and Management Accounting BI-FMU** Z,ZK 5 2P+2C Ζ David Buchtela David Buchtela David Buchtela (Gar.) **Financial Markets** BI-FTR.1 Z.ZK 5 2P+2C L Pavla Vozárová Games and reinforcement learning NI-GLR 4 2P+2C L Z,ZK Juan Pablo Maldonado Lopez Graph Neural Networks NI-GNN Z,ZK 4 1P+1C L Miroslav epek Miroslav epek (Gar.) **Grid Computing**André Sopczak, Petr Fiedler **Pavel Tvrdík** André Sopczak (Gar.) Ζ NI-GRI Z,ZK 5 2P+1C Mind Hacking NI-HCM ZK 5 Ζ 2P+1C Marcel Ji ina, Josef Holý **Marcel Ji ina** Marcel Ji ina (Gar.) Side-Channel Analysis in Hardware NI-HSC Z.ZK 4 2P+2C 7 V Vojt ch Miškovský, Petr Socha Petr Socha Vojt ch Miškovský (Gar.)

NI-HMI2	History of Mathematics and Informatics  Alena Šolcová Alena Šolcová Alena Šolcová (Gar.)	ZK	3	2P+1C	Z	V
NI-IBE	Information Security Igor ermák	ZK	2	2P	Z	V
NI-IVS	Intelligent embedded systems Miroslav Skrbek Miroslav Skrbek (Gar.)	KZ	4	1P+3C	L	V
NI-IKM	Internet and Classification Methods  Martin Hole a Martin Hole a Martin Hole a (Gar.)	Z,ZK	4	1P+1C	L	V
NI-IAM	Internet and Multimedia	Z,ZK	4	2P+1C	L	V
NI-IOT	Internet of Things Jan Jane ek Jan Jane ek (Gar.)	Z,ZK	4	2P+1C	L	V
BI-JPO.21	Computer Units Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-KTH	Combinatorial Theories of Games Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+1C	L	V
NI-FMT	Finite model theory Tomáš Jakl Tomáš Jakl (Gar.)	Z,ZK	4	2P+1C	L	V
NI-CCC	Creative Coding and Computational Art Radek Richtr. Josef Kortán Radek Richtr Radek Richtr (Gar.)	KZ	4	1P+2C	Z,L	V
NI-KYB	Cybernality	ZK	5	2P	Z	V
NI-LSM2	Statistical Modelling Lab Kamil Dedecius Kamil Dedecius (Gar.)	KZ	5	3C	Z,L	V
NI-LOM	Linear Optimization and Methods  Dušan Knop Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPL	Managerial Psychology	ZK	2	2P	Z,L	V
NI-MSI	Jan Fiala Jan Fiala (Gar.)  Mathematical Structures in Computer Science	Z,ZK	4	2P+1C	L	V
NI-MZI	Jan Starý Jan Starý (Gar.)  Mathematics for data science	Z,ZK	4	2P+1C	L	V
BI-MPP.21	St pán Starosta  Methods of interfacing peripheral devices	Z,ZK	5	2P+2C	Z	V
NI-MOP	Miroslav Skrbek Miroslav Skrbek Miroslav Skrbek (Gar.)  Modern Object-Oriented Programming in Pharo	KZ	4	3C	 	V
NI-NMU	Marek Skotnica, Jan Blizni enko <b>Robert Pergl</b> Robert Pergl (Gar.)  New media in art and design	ZK	3	2P+0C	Z	V
NI-OLI	Zden k Svejkovský <b>Zden k Svejkovský</b> Zden k Svejkovský (Gar.) <b>Linux Drivers</b>			2P+2C	_	
INI-OLI	Jaroslav Borecký, Miroslav Skrbek <b>Jaroslav Borecký</b> Miroslav Skrbek (Gar.)  Personalized Machine Learning	Z,ZK	4	2P+2C	L	V
NIE-PML	Rodrigo Augusto Da Silva Alves <b>Karel Klouda</b> Rodrigo Augusto Da Silva Alves (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-PG1	Computer Grafics 1 Radek Richtr Radek Richtr (Gar.)	ZK	4	2P+1C	L	V
NI-EDW	Enterprise Data Warehouse Systems  Jakub Krej í, Robert Kotlá <b>Jakub Krej í</b> Magda Friedjungová (Gar.)	Z,ZK	5	1P+1C	L	V
NI-PVR	Advanced Virtual Reality Petr Pauš Petr Pauš (Gar.)	KZ	4	2P+1C	Z	V
NI-AML	Advanced machine learning Zden k Buk, Miroslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimánek, Vojt ch Rybá <b>Miroslav epek</b> Miroslav epek (Gar.)	Z,ZK	5	2P + 1C	L	V
NI-IOS	Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)	KZ	4	2P+2C	L	V
NI-APT	Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PVS	Advanced embedded systems  Miroslav Skrbek	Z,ZK	4	2P+2C	Z	V
NI-DNP	Advanced .NET  Nikolas Jíša Nikolas Jíša (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-PYT	Advanced Python  Miroslav Hron ok	KZ	4	3C	Z	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Martin Barus (Gar.)	KZ	5	2P+1C	Z	V
BI-PJP.21	Programming Languages and Compilers Jan Janoušek, Št pán Plachý, Tomáš Pecka Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PSL	Programming in Scala Ji í Dan ek <b>Ji í Dan ek</b> Ji í Dan ek (Gar.)	Z,ZK	4	2P+1C	Z	V
BI-PMA	Programming in Mathematica Zden k Buk Zden k Buk Zden k Buk (Gar.)	Z,ZK	4	2P+2C	Z	V
NI-RUB	Programming in Ruby	KZ	4	3C	Z	V
NI-ROZ	Cyril erný Cyril erný Cyril erný (Gar.)  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)	Z,ZK	5	2P+1C	Z	V

NI-SCE1	Computer Engineering Seminar Master I Hana Kubátová Miroslav Skrbek Hana Kubátová (Gar.)	Z	4	2C	L,Z	V
NI-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L,Z	V
NI-SZ1	Knowledge Engineering Seminar Master I Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	V
NI-SZ2	Knowledge Engineering Seminar Master II Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	V
PI-SCN	Seminars on Digital Design Petr Fišer Petr Fišer (Gar.)	ZK	4	2P+1C	Z,L	V
BI-SOJ	Machine Oriented Languages	Z,ZK	4	2P+2C	L	V
NI-MLP	Machine Learning in Practice Jan Hu in Daniel Vašata Jan Hu in (Gar.)	Z,ZK	5	2P+1C	Z	V
BI-SVZ.21	Machine vision and image processing Lukáš Brchl, Marcel Ji ina, Jakub Novák Jakub Novák Marcel Ji ina (Gar.)	Z,ZK	5	2P+2C	L,Z	٧
NI-SEP	World Economy and Business Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	٧
BI-SRC.21	Real-time systems Hana Kubátová Jaroslav Borecký Hana Kubátová (Gar.)	Z,ZK	5	2P+2C	Z	٧
NI-TVR	Virtual Reality Technology Tomáš Nová ek Tomáš Nová ek (Gar.)	Z,ZK	3	1P+1C	L,Z	V
NI-TS1	Theoretical Seminar Master I Dušan Knop, Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	V
NI-TS2	Theoretical Seminar Master II Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	L	V
NI-TS3	Theoretical Seminar Master III Ond ej Guth, Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	V
NI-TS4	Theoretical Seminar Master IV Ond ej Suchý, Tomáš Valla Tomáš Valla Ond ej Suchý (Gar.)	Z	4	2C	L	V
NI-TKA	Category Theory Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-TNN	Theory of Neural Networks Martin Hole a Martin Hole a (Gar.)	Z,ZK	5	2P+1C	L	V
NI-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	V
BI-CCN	Compiler Construction Christoph Kirsch Christoph Kirsch (Gar.)	Z,ZK	5	3P	L	V
NI-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
BI-VHS.21	Virtual game worlds Radek Richtr Radek Richtr (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-VOL	Elections Dušan Knop Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	L	V
BI-VMM	Selected Mathematical Methods Tomáš Kalvoda Tomáš Kalvoda (Gar.)	Z,ZK	4	2P+2C	L	V
NI-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NI-VPR	Research Project Št pán Starosta Št pán Starosta (Gar.)	Z	5		Z,L	V
NI-ZS10	Master internship abroad for 10 credits  Zden k Muziká Zden k Muziká (Gar.)	Z	10		Z,L	V
NI-ZS20	Master internship abroad for 20 credits  Zden k Muziká Zden k Muziká (Gar.)	Z	20		Z,L	V
NI-ZS30	Master internship abroad for 30 credits	Z	30		Z,L	V

#### Characteristics of the courses of this group of Study Plan: Code=NI-V.2021 Name=Purely Elective Master Courses, Version 2021

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.

NI-ATH AlgorithmicTheories of Games

Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibrian

(players) of a certain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation.

BI-AG2.21 Algorithms and Graphs 2

Z,ZK | 5

Z,ZK

This course, presented in Czech, introduces basic algorithms and concepts of graph theory as a follow=up on the introduction given in the compulsory course BI-AG1.21. It further delves into advances data structures and amortized complexity analysis. It also includes a very light introduction to approximation algorithms. For English version of the course see BIE-AG2.21.

NI-AFP Applied Functional Programming

Advanced Program Testing

KZ |

5

This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice.

NI-APH Architecture of computer games	Z,ZK	4
Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but	=	
perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base	•	•
part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An imigration of a simple game, with a strong focus on nontrivial game mechanics.	iportant part of the	course is air
BI-APS.21 Architectures of Computer Systems	Z,ZK	5
Students will learn the construction principles of internal architecture of computers with universal processors at the level of machine instructions. Specific		_
pipelined instruction processing and on the memory hierarchy. Students will understand the basic concepts of RISC and CISC architectures and the pipelined instruction processing and on the memory hierarchy.	•	
not only in scalar processors, but also in superscalar processors that can execute multiple instructions in one cycle, while ensuring the correctness of	•	
program. The course further elaborates the principles and architectures of shared memory multiprocessor and multicore systems and the memory of	oherence and cons	sistency in such
systems.	7.71	
NI-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 broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get kno		
for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.	wiedge of security	mechanisms
BI-BEK.21 Secure Code	Z,ZK	5
The students will learn how to assess security risks and how to take them into account in the design phase of their own code and solutions. After getting	1	_
theory, students gain practical experience with running programs with reduced privileges and methods of specifying these privileges, since not every	y program needs to	run with
administrator privileges. Dangers inherent in buffer overflows will be practically demonstrated. Students will be introduced to the principles of securing	-	-
security and database systems, web, remote procedure calls, and sockets in general. The module concludes with Denial of Service attacks and the		
BI-BLE Blender	Z,ZK	. 4
The course extends knowledge of opensource program Blender from BI-MGA (Multimedia and Graphics Applications) course. It is intended for those animation. It offers a complete and practically oriented introduction to Blender environment. Students may continue to BI-PGA (Programming graphic	-	
		5
NIE-BLO Blockchain Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain pla	Z,ZK	_
code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place		
relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares		•
supervising implementation of blockchain-based solutions in both academia and business.		-
NI-CTF Capture The Flag	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.		
NI-DPH Game Design	Z,ZK	5
The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on gar	-	
interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics		
development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical improjects	iplementation appli	ed to semestral
NI-DSW Design Sprint	7	2
Students will work on projects using the Design Sprint method, developed by Google. Thanks to this method the teams are able to go from idea to va	. – .	<del>-</del>
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BI-FMU Financial and Management Accounting  The size of the course is explanation of basis terms in the theory of accounting the principles of belonging the preparity amounts and liabilities in the		
The aim of the course is evalenation of hasis terms in the theory of accounting the principles of helenaing the preparty amounts and lightlities in the	Z,ZK	5
The aim of the course is explanation of basic terms in the theory of accounting, the principles of balancing the property amounts and liabilities in the	•	
operations in accounts and accounting statements including opening and closing of bookkeeping. The course provides students with a legal modific		
of economic operations based on current methods of double-entry bookkeeping for enterprising subjects in the Czech Republic. Principles of mana Business Inteligence moduls in Business information systems.	gement accounting	are base or
BI-FTR.1 Financial Markets	Z,ZK	5
This course is presented in Czech. However, there is an English variant in the program Informatics (B1801 / 4753).	Z,ZK	5
	Z,ZK	4
NI-GLR Games and reinforcement learning  The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelli	1 '	•
give you both theoretical and practical background so you can participate in related research activities. Presented in English.	igence. This course	is interided to
NI-GNN Graph Neural Networks	Z,ZK	4
The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural	1 ' 1	•
representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The las		- 1
graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.	.,	
NI-GRI Grid Computing	Z,ZK	5
Grid computing and gain knowledge about the world-wide network and computing infrastructure.	, ,	
NI-HCM Mind Hacking	ZK	5
Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks	, information syste	ms and assets,
the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive security	ecurity is growing in	importance in
the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Inte	rnet environment h	ave real societal
impacts such as disruption of social cohesion, threats to democracy or war.		
NI-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 att	•	
various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks a	-	higher-order
attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information of the		
NI-HMI2 History of Mathematics and Informatics	ZK	3
This course is presented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms and its development.	ims, transformation	is, recursive
functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development.  NI-IBE Information Security	ZK	2
NI-IBE   Information Security   Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internal		_
understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., per		tilis area. Triey
NI-IVS Intelligent embedded systems	KZ	4
Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence.	1	-
of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot progra		
development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, stude	=	
combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies		
NI-IKM Internet and Classification Methods	Z,ZK	4
In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filt	ering, in recommer	dation systems,
in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solve	ring these four kind	s of problems.
On the background of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle.		ures and 2-hour
exercises. During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult the		
NI-IAM Internet and Multimedia	Z,ZK	4
	1 ' 1	-
The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes a	acquisition of AV sig	gnals (input),
The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes a presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at pract	acquisition of AV significal use case scena	gnals (input), arios of real-time
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NI-CCC	Creative Coding and Computational Art	KZ	4
Students work on practic	cal tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows t	he basic graphics	courses (MGA,
BLE,) and introduces	students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techni	ques with artistic	methods using
modern technologies. The	ne aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture an	d Metropolitan Pl	anning) and IIM
(Institute of Intermedia F	EL).		
NI-KYB	Cybernality	ZK	5
Students get acquainted	l with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the	ne classification d	of attacks and
have an overview of sys	tems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker a	ctivities and beha	vior. The course
will also discuss the coo	peration of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams).		
NI-LSM2	Statistical Modelling Lab	KZ	5
The topic of LSM2 is ad	vanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the pre	sence of clutter, c	r video tracking.
We aim at the state-of-th	ne-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters.		-
NI-LOM	Linear Optimization and Methods	Z,ZK	5
	cations of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear	, ,	-
	timization software and are familiar with languages used in programming of that software. They get skills in formalization of o		
•	ling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, trav		
•	and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. T		
in linear programming.	, 9	, g	
NI-MPL	Managerial Psychology	ZK	2
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
	of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scot	t model of lambda	a calculus.
Introduction to category			
NI-MZI	Mathematics for data science	Z,ZK	4
	are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used ir		
-	gebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality prin	ciple, gradient me	ethods) and
selected notions from pr	obability theory and statistics.		
BI-MPP.21	Methods of interfacing peripheral devices	Z,ZK	5
The course is focused o	n methods for interfacing of peripheral devices. Interfacing of real peripheral devices is focused on techniques based on Unive	ersal serial bus (Ú	SB). The course
includes both PC side a	nd peripheral devices side. Labs are practically oriented. Students gain experience with implementation of relevant parts of U	SB devices, Linu	x and Windows
drivers, simple application	on development, and APIs of selected devices.		
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
Object-oriented program	nning is currently one of the most widespread paradigms of software creation, especially enterprise information systems, who	ere its ability to na	tural abstraction
is used to build complex	modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the s	kills of design and	l implementation
of object systems in mo-	dern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development	needs and areas	of interest. In
addition to deepening of			
addition to accepting of	oject programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to wor	rk on interesting p	projects and OO
· · · · ·	oject programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to wol semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involv		-
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NI-PVS	Advanced embedded systems	Z,ZK	4
The course is focused of	n ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advan	nced topics like se	curity support,
working with mass stora	ge devices, motor control, system control and industrial communication. The students obtain both theoretical and also practi	cal experiences w	ith embedded
systems.			
NI-DNP	Advanced .NET	Z,ZK	4
Students will acquire an	overview of platform .NET and will gain knowledge about technologies ASP.NET, Entity Framework, WPF, .NET MAUI and a	lso will get notion	s of Azure
DevOps and GIT. Stude	nts will get practical experience in semestral work where they will create a client-server application utilizing technologies AS	P.NET, Entity Fran	nework and
(Blazor, .NET MAUI or V	VPF) and also Azure DevOps and GIT.		
NI-PYT	Advanced Python	KZ	4
The goal of this course i	s to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Pyth	non (BI-PYT) left o	f. The course is
very hands-on and it has	s only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursew	ork. The course is	lead by external
teachers from Red Hat.			
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 framewo	rk. Throughout
the course, students will	develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su	ich as computer vi	ision and natural
language processing.			
	Programming Languages and Compilers	Z,ZK	5
Students learn basic co	mpiling methods of programming languages. They are introduced to intermediate representations used in current compilers	GNU and LLVM. T	hey learn to
•	a translation of a text that conforms a given syntax, to a target code and also to create a compiler based on the specification	n. The compiler ca	in translate not
	guage but any text in a language generated by a given LL input grammar.		
NI-PSL	Programming in Scala	Z,ZK	4
	he modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language fea		_
•	/. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks	and libraries e.g. I	Play, Cassandra,
Scalaz, etc.			
BI-PMA	Programming in Mathematica	Z,ZK	4
Students will be working	with modern technical and scientific software. Students will learn how to use different programming styles (functional progra	amming, rule-base	ed programming,
etc.), how to create dyna	amic interactive applications and visualisations, data processing and presentations.		
NI-RUB	Programming in Ruby	KZ	4
This course is presented	d in Czech.		
NI-ROZ	Pattern Recognition	Z,ZK	5
The aim of the module is	s to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the s	statistical approac	h to pattern
recognition. Students wi	Il learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a	nd their numerical	aspects.
NI-SCE1	Computer Engineering Seminar Master I	Z	4
The Seminar of Comput	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	ce to failures and a	attacks. Students
are approached individu			
are approached individu	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	the subject is worl	k with scientific
	ially within the subject. Each student or group or students solves some interesting topic with the selected supervisor. Part of issional literature and/or work in K=N laboratories. The capacity of the subject is limited by the possibilities of the seminar team	•	
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articles and other professemester.  NI-SCE2	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar team	chers. The topics a	are new for each
articles and other professemester.  NI-SCE2 The Seminar of Comput	csional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar team.  Computer Engineering Seminar Master II	chers. The topics a	4 attacks. Students
articles and other professemester.  NI-SCE2  The Seminar of Computare approached individual	Computer Engineering Seminar Master II er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance.	chers. The topics a  Z  ce to failures and a the subject is worl	4 attacks. Students k with scientific
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BI-SRC.21			
	Real-time systems	Z,ZK	5
	c knowledge in the real-time (RT) system theory and in the design methods for RT systems including the dependability issue		•
course.	entally verified in computer labs. The course is mainly focused on embedded RT systems, therefore the design kits in the lab	are the same as	In the BIE-VES
NI-TVR	Virtual Reality Technology	Z,ZK	3
	sed to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of co	, , , , , , , , , , , , , , , , , , ,	_
tracking, hand tracking,	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways o	of using virtual and	d augmented
reality will be presented			
NI-TS1	Theoretical Seminar Master I	Z	4
	tended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a clas and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	0.0	•
=	The capacity is limited by the the potentials of the teachers of the seminar.	a work with sciel	illic papers and
NI-TS2	Theoretical Seminar Master II	Z	4
Theoretical seminar is in	tended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class	ssical reading gro	up. The students
•	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	a work with scier	ntific papers and
	The creation I Committee by the the potentials of the teachers of the seminar.	7	4
NI-TS3 Theoretical seminar is in	Theoretical Seminar Master III tended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class	Z Z	4 in The students
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		•
,	. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS4	Theoretical Seminar Master IV	Z	4
	tended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class		· ·
•	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	a work with scier	ntific papers and
	The capacity is limited by the the potentials of the teachers of the seminar.	7 7V	1
NI-TKA	Category Theory Theory of Neural Networks	Z,ZK Z,ZK	4 5
NI-TNN In this course, we study	neural networks from the point of view of the theory of function approximation and from the point of view of probability theory		-
· · · · · · · · · · · · · · · · · · ·	ural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmissic		
· -	ork training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transform	-	
	omatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with tra		
-	and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most		
	vork training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within rst notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko		• • •
	e will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappi	-	
	t Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect		
	s derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on exp		-
• •	n probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see he	•	0
•	ancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak la ogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the cent	_	_
•	al networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be		
topology of the network			
NI-CPX	Complexity Theory		
		Z,ZK	5
(in)tractability of difficult BI-CCN	t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		
	problems.	ne theory concern	ing practical
	problems.  Compiler Construction	Z,ZK	ing practical 5
	problems.	Z,ZK	ing practical 5
understand the design a	problems.  Compiler Construction lass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles	Z,ZK	ing practical 5
understand the design a	problems.  Compiler Construction lass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching theme	Z,ZK s of compilers for of the class. Z,ZK	5 students to
understand the design a NI-DVG The course intends to in of this discipline, and to	Compiler Construction lass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching theme Introduction to Discrete and Computational Geometry troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar value to solve simple algorithmic problems with a geometric component.	Z,ZK s of compilers for of the class. Z,ZK with the most fund	5 students to  5 amental notions
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understand the design a NI-DVG The course intends to in of this discipline, and to BI-VHS.21 In the course students le	Compiler Construction lass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching theme Introduction to Discrete and Computational Geometry troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar value able to solve simple algorithmic problems with a geometric component.  Virtual game worlds arn methods to create a complex virtual world. It is a follow-up course of basic courses of the PG specialization (BIE-MGA, BIE-MGA,	Z,ZK s of compilers for of the class. Z,ZK with the most fund Z,ZK =-PGR). Students	5 students to  5 amental notions  5 gain knowledge
understand the design a NI-DVG The course intends to in of this discipline, and to BI-VHS.21 In the course students le of the theory of game design and the students are the students and the students are the stu	Compiler Construction lass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching theme Introduction to Discrete and Computational Geometry troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar value able to solve simple algorithmic problems with a geometric component.  Virtual game worlds arn methods to create a complex virtual world. It is a follow-up course of basic courses of the PG specialization (BIE-MGA, BIE sign, of principles of writing dialogues and characters in order to create a functional virtual world. Within the labs they get practice.	Z,ZK s of compilers for of the class. Z,ZK with the most fund Z,ZK =-PGR). Students	5 students to  5 amental notions  5 gain knowledge
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understand the design a NI-DVG The course intends to in of this discipline, and to BI-VHS.21 In the course students to of the theory of game do work on the semester p NI-VOL We will cover the basics BI-VMM We start reviewing geor	Compiler Construction  ass on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching theme.  Introduction to Discrete and Computational Geometry  troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar was able to solve simple algorithmic problems with a geometric component.  Virtual game worlds  arn methods to create a complex virtual world. It is a follow-up course of basic courses of the PG specialization (BIE-MGA, BIE sign, of principles of writing dialogues and characters in order to create a functional virtual world. Within the labs they get practiciples.  Elections  of (committee) elections and, in general, opinion aggregation.  Selected Mathematical Methods  netric properties of linear spaces with inner product. Next, we introduce and analyze the discrete Fourier transform (DFT) and	Z,ZK s of compilers for of the class. Z,ZK with the most fund Z,ZK E-PGR). Students cal skills within tea	5 students to  5 amental notions  5 gain knowledge am development  5 4 ntation (FFT).
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NI-ZS20 Master internship abroad for 20 credits

Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.

NI-ZS30 Master internship abroad for 30 credits

Z

30

The course is prezented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.

Code of the group: NI-SP-VS.20

Name of the group: Elective Vocational Courses for Master Specialization System Programming

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

Credits in the group: 0

Note on the group:

Povinné předměty všech specializací s výjimkou této specializace.

Note on the group	5: Povinne preamety vsech speci	alizaci s vyji	ilikou le	to speci	alizace.	
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
NI-ADM	Data Mining Algorithms Pavel Kordík, Daniel Vašata, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz, Olha Jure ková Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ADP	Architecture and Design patterns Filip K ikava, Jan Zimolka, Ji í Borský, Tomáš Chvosta Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM1	Middleware Architectures 1 Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM2	Middleware Architectures 2 Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	L	V
NI-BML	Bayesian Methods for Machine Learning Kamil Dedecius, Ond ej Tichý Kamil Dedecius (Gar.)	KZ	5	2P+1C	L	V
NI-BVS	Embedded Security Martin Novotný Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NI-BKO	Error Control Codes Pavel Kubalík, Alois Pluhá ek Alois Pluhá ek (Gar.)	Z,ZK	5	2P+1C	L	V
NI-DSV	Distributed Systems and Computing Pavel Tvrdík Jan Fesl Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DDW	Web Data Mining Jaroslav Kucha, Milan Doj inovski Jaroslav Kucha Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	V
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	V
NI-GAK	Graph theory and combinatorics Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V
NI-HWB	Hardware Security Ji í Bu ek, Róbert Lórencz <b>Ji í Bu ek</b> Ji í Bu ek (Gar.)	Z,ZK	5	2P+2C	L	V
NI-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NI-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	V
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MEP	Modelling of Enterprise Processes Robert Pergl, Marek Suchánek, Marek Skotnica Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	z	V
NI-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek, Jan Verelst Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	V

NI-BUI	Business Informatics Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	V
NI-PIS	Enterprise Information Systems Martin Závrbský, Martin Mach, Vlastimil Jinoch, Martin Hasaj David Buchtela David Buchtela (Gar.)	Z,ZK	5	2P+1C	L	V
NI-KRY	Advanced Cryptology Ji í Bu ek, Róbert Lórencz, Simona Forn sek <b>Ji í Bu ek</b> Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-PAS	Advanced Aspects of Business David Buchtela, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-PDB	Advanced Database Systems Michal Valenta, Yelena Trofimova Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PDD	Data Preprocessing Marcel Ji ina Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-REV	Reverse Engineering Ji í Dostál, Josef Kokeš, Róbert Lórencz <b>Ji í Dostál</b> Ji í Dostál (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski, Jakub Klímek Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SIB	Network Security Ji í Dostál, Simona Forn sek, Martin Šutovský Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SCR	Statistical Analysis of Time Series Kamil Dedecius Kamil Dedecius (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SYP	Parsing and Compilers  Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SBF	System Security and Forensics Simona Forn sek, Marián Svetlík Simona Forn sek	Z,ZK	5	2P+1C	Z	V
NI-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl, David Buchtela David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TES	Systems Theory Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TSP	Testing and Reliability Petr Fišer Martin Da hel Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-TSW	Software Product Development Petra Pavlí ková Ond ej Pluha Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	V
NI-UMI	Artificial intelligence Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PON	Selected Topics in Optimization and Numerical mathematics Karel Klouda, Št pán Starosta, Daniel Vašata Daniel Vašata Št pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VMM	Retrieval from Multimedia Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MCC	Multicore CPU Computing  Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V

Characteristics of the courses of this group of Study Plan: Code=NI-SP-VS.20 Name=Elective Vocational Courses for Master Specialization System Programming

NI-SYP 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.

NI-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).

NI-AIB Algorithms of Information Security

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

NI-ADP Architecture and Design patterns Z,ZK 5

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

NI-AM1 Middleware Architectures 1 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. NI-AM2 Middleware Architectures 2 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. NI-BML Bayesian Methods for Machine Learning ΚZ The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them. NI-RVS **Embedded Security** 7.7K 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. NI-BKO **Error Control Codes** Z,ZK 5 The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels. Distributed Systems and Computing NI-DSV 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. Web Data Mining 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. Efficient Text Pattern Matching Z.ZK 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. 5 NI-FMF Formal Methods and Specifications 7.7K 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. NI-GAK Graph theory and combinatorics Z,ZK 5 The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and 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. 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. NI-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. NI-MKY Mathematics for Cryptology Z.ZK 5 Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In 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. Z.ZK NI-MVI Computational Intelligence Methods 5 Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to many problems. They will learn how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc. Modelling of Enterprise Processes The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions. NI-MTI Modern Internet Technologies Z.ZK 5 SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration - A single network, oriented on TCP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video and data to achieve seamless integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of millions of users and billions of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and Traffic Prioritisation - These technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, delay, jitter, type of protocol). 4. Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of failures. NI-NUR User Interface Design Z,ZK 5 Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs. Nonlinear Continuous Optimization and Numerical Methods 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.

NI-NSS	Normalized Software Systems	ZK	5
	oundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineer	-	
	thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related is		
	nd part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements on systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stab		•
	students to realize new levels of evolvability in software architectures.	ility and entropy-re	siated principles.
NI-BUI	Business Informatics	Z,ZK	5
	to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of		-
ICT services and archite	ectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manager	ment, and lifecycle	e management
	ource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governa	· ·	
	tt of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manageme	nt, revenue and in	nvestment
	nent evaluation and human resources management in IT (roles CIO, CEO, CFO).	7 71/	
NI-PIS	Enterprise Information Systems	Z,ZK	5
	n the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage c nce). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication		
· -	lore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the		-
•	ated with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation	• • • • • • • • • • • • • • • • • • • •	
company / organization.			
NI-KRY	Advanced Cryptology	Z,ZK	5
	ssentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know		
_	tors. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they	can apply to the i	ntegration of
<u>.</u>	the creation of their own software solutions.	· ·	
NI-PAS	Advanced Aspects of Business	Z,ZK	4
	to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run the law, administration (necessary steps and documents), business economics, foreign trade and related aspects.	ieir own business	or business
NI-PDB	Advanced Database Systems	Z,ZK	5
	ves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of datab		- 1
	ated new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CY	•	
•	erformance evaluation of database machines.	,	
NI-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain knowl	edge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the	CUDA programmi	ng environment,
-	pread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical	computational stru	ictures, students
•	on programming techniques and methods of programming multiprocessor GPU systems.		
NI-PDD	Data Preprocessing	Z,ZK	5
	re raw data for further processing and analysis. They learn what algorithms can be used to extract information from various da		- 1
		rictice from imaga	c or from woh
	arn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of character	ristics from image	s or from web
pages.			
pages. NI-REV	Reverse Engineering  Intelligent with the essentials of reverse engineering of computer software. They will learn how processes start and what happens	Z,ZK	5
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NI-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 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. Software Product Development ΚZ The course is presented in Czech. Z.ZK NI-UMI Artificial intelligence 5 The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated. NI-EHW **Embedded Hardware** Z,ZK 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. **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. Virtualization and Cloud Computing 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). Selected Topics in Optimization and Numerical mathematics The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-VMM Retrieval from Multimedia Z,ZK The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines. NI-MCC Multicore CPU Computing 7.7K 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 memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening 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.

#### List of courses of this pass:

Completion Credits

Name of the course

Code

0 0 0.0		,	
BI-AG2.21	Algorithms and Graphs 2	Z,ZK	5
This course, pres	ented in Czech, introduces basic algorithms and concepts of graph theory as a follow=up on the introduction given in the compulsory	course BI-AG1.21	l. It further
delves into advan	ces data structures and amortized complexity analysis. It also includes a very light introduction to approximation algorithms. For Engl	ish version of the o	course see
	BIE-AG2.21.		
BI-APS.21	Architectures of Computer Systems	Z,ZK	5
Students will lear	n the construction principles of internal architecture of computers with universal processors at the level of machine instructions. Spec	cial emphasis is giv	en on the
pipelined instruction	n processing and on the memory hierarchy. Students will understand the basic concepts of RISC and CISC architectures and the princ	ciples of instruction	processing
not only in scalar	processors, but also in superscalar processors that can execute multiple instructions in one cycle, while ensuring the correctness of	the sequential mo	del of the
program. The cours	e further elaborates the principles and architectures of shared memory multiprocessor and multicore systems and the memory cohe	rence and consiste	ency in such
	systems.		
BI-BEK.21	Secure Code	Z,ZK	5
The students will le	arn how to assess security risks and how to take them into account in the design phase of their own code and solutions. After getting fa	amiliar with the thre	at modeling
theory, students	gain practical experience with running programs with reduced privileges and methods of specifying these privileges, since not every	program needs to	run with
administrator priv	ileges. Dangers inherent in buffer overflows will be practically demonstrated. Students will be introduced to the principles of securing	data and the relative	onships of
security and	database systems, web, remote procedure calls, and sockets in general. The module concludes with Denial of Service attacks and the	e defense against	them.
BI-BLE	Blender	Z,ZK	4
The course extend	ds knowledge of opensource program Blender from BI-MGA (Multimedia and Graphics Applications) course. It is intended for those i	nterested in 3D gra	aphics and
animation. It o	ffers a complete and practically oriented introduction to Blender environment. Students may continue to BI-PGA (Programming grapl	nics applications) c	ourse.
BI-CCN	Compiler Construction	Z,ZK	5
This is an introdu	ctory class on compiler construction for bachelor students in computer science. The goal of the class is to introduce basic principles	of compilers for st	udents to
understa	nd the design and implementation of programming languages. Seeing and actually understanding self-compilation is the overarching	theme of the class	S
BI-EHA.21	Ethical Hacking	Z,ZK	5
The goal of the co	ourse is to introduce students to the field of penetration testing and ethical hacking. The course deals with cybersecurity threats, vuln	erabilities, and the	ir possible
exploitation in com	nputer networks, web applications, wireless networks, operating systems, and others like the Internet of Things or cloud. The focus is	on hands-on expe	rience with
	vulnerabilities testing and the following process of penetration test documentation.		
BI-FMU	Financial and Management Accounting	Z,ZK	5
The aim of the cou	rse is explanation of basic terms in the theory of accounting, the principles of balancing the property amounts and liabilities in the pa	rticular accounting	operations,
operations in acco	unts and accounting statements including opening and closing of bookkeeping. The course provides students with a legal modification	n of bookkeeping,	description

of economic operations based on current methods of double-entry bookkeeping for enterprising subjects in the Czech Republic. Principles of management accounting are base of Business Inteligence moduls in Business information systems. BI-FTR.1 Z,ZK 5 Financial Markets This course is presented in Czech. However, there is an English variant in the program Informatics (B1801 / 4753). BI-JPO.21 Computer Units Z.ZK 5 Students deepen their basic knowledge of digital computer units acquired in the obligatory course of the program (BIE-SAP), get acquainted in detail with the internal structure and organization of computer units and processors and their interactions with the environment, including accelerating arithmetic-logic units and using appropriate codes for implementation of multiplication. The organization of main memory and other internal memories (addressable, LIFO, FIFO and CAM) will be discussed in detail, including codes for error detection and correction for parallel and serial data transmissions. They will also get acquainted with the methodology of controller design, with the principles of communication of the processor with the environment and the architecture of the bus system. The problems will be practically evaluated in the labs and with the help of the educational microprogrammed processor simulator and programmable hardware design kits (FPGA). BI-MPP.21 Methods of interfacing peripheral devices Z,ZK 5 The course is focused on methods for interfacing of peripheral devices. Interfacing of real peripheral devices is focused on techniques based on Universal serial bus (USB). The course includes both PC side and peripheral devices side. Labs are practically oriented. Students gain experience with implementation of relevant parts of USB devices, Linux and Windows drivers, simple application development, and APIs of selected devices. BI-PJP.21 Programming Languages and Compilers Z,ZK 5 Students learn basic compiling methods of programming languages. They are introduced to intermediate representations used in current compilers GNU and LLVM. They learn to create a specification of a translation of a text that conforms a given syntax, to a target code and also to create a compiler based on the specification. The compiler can translate not only a programming language but any text in a language generated by a given LL input grammar. **BI-PMA** Programming in Mathematica Z,ZK 4 Students will be working with modern technical and scientific software. Students will learn how to use different programming styles (functional programming, rule-based programming, etc.), how to create dynamic interactive applications and visualisations, data processing and presentations. Machine Oriented Languages Students of the course will gain an ability to create their own programs in the assembly language of the most common PC platform focusing on optimal use of microprocessor's features and efficient cooperation of software with hardware. Next, there will be discussed x86 specifics of the majority of OSes from the application point of view linked to higher level languages. This knowledge will be used during reverse engineering, optimization, and evaluation of code security. BI-SRC.21 Real-time systems Students obtain the basic knowledge in the real-time (RT) system theory and in the design methods for RT systems including the dependability issues. Theoretical knowledge from lectures will be experimentally verified in computer labs. The course is mainly focused on embedded RT systems, therefore the design kits in the lab are the same as in the BIE-VES course. BI-SVZ.21 Machine vision and image processing Z.ZK 5 Camera systems are becoming a common part of life by being universally available. Related to this phenomenon is the need to process and evaluate image information. The course introduces students to different types of camera systems and a variety of methods for image and video processing. The course is focused on practical use of camera systems for solving problems of practice that the graduates may encounter. BI-VHS.21 Virtual game worlds Z,ZK 5 In the course students learn methods to create a complex virtual world. It is a follow-up course of basic courses of the PG specialization (BIE-MGA, BIE-PGR). Students gain knowledge of the theory of game design, of principles of writing dialogues and characters in order to create a functional virtual world. Within the labs they get practical skills within team development work on the semester project. **BI-VMM** Selected Mathematical Methods Z,ZK We start reviewing geometric properties of linear spaces with inner product. Next, we introduce and analyze the discrete Fourier transform (DFT) and its fast implementation (FFT). Further we deal with differential calculus of functions involving multiple variables. We present methods for the localization of extreme values of functions. For this purposes, we study normed linear spaces and quadratic forms. In addition, we introduce the least square method. The last part of the course is devoted to optimization and duality. The linear programming and the Simplex method is analyzed in more detail. NI-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). NI-ADP Architecture and Design patterns Z.ZK 5 The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems. NI-AFP Applied Functional Programming ΚZ 5 This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice. NI-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. NI-AM1 Middleware Architectures 1 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. NI-AM2 Middleware Architectures 2 7.7K 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. 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-APH	Architecture of computer games	Z,ZK	4
J	basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also	0 1	
	vill get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base co es. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An impo	-	- 1
F 9	implementation of a simple game, with a strong focus on nontrivial game mechanics.		
NI-APR	Selected Methods for Program Analysis	Z,ZK	5
	studies program behavior with the aim of code optimization and error detection. Students will learn static program analysis, which ap		
without the need	to actually run the program, as well as dynamic program analysis which analyse programs at runtime. Students will be introduced to algorithms and use them on some classical problems.	the common techni	ques and
NI-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 go		to present
	advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.		
NI-ARI	Computer arithmetic Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementar	Z,ZK	4
NI-ATH	AlgorithmicTheories of Games	Z,ZK	4
_	theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies		- 1
	ain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game to	=	- 1
	s of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social network s and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of ef		- 1
	concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods o		
NI-BKO	Error Control Codes	Z,ZK	5
	al of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transn	nitted via channels.	
NI-BML	Bayesian Methods for Machine Learning	KZ	5
•	sed on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies t description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden v		
	tions etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a	,	•
=	will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging.		- 1
	some of them.		
NI-BPS	Wireless Computer Networks	Z,ZK	4
	n about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad nisms, 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 suitab	-	
NI-BUI	Business Informatics	Z,ZK	5
The aim of the cours	se is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of b	usiness process ma	anagement.
			- 1
ICT services and a	architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management (sourcing). Students will learn the process of creating and implementing information strategy. IT Government		anagement
ICT services and a of ICT services ar	nd resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance	ce, the importance	anagement of ICT for
ICT services and a of ICT services ar		ce, the importance	anagement of ICT for
ICT services and a of ICT services are business and the	nd resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manageme management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).  Embedded Security	ce, the importance ont, revenue and inv	anagement of ICT for restment
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development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semestral projects. NI-DSS **Decision Support Systems** 7 7K 5 The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-oriented and knowledge-oriented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will also learn about the principles of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms. NI-DSV Distributed Systems and Computing Z,ZK 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. NI-DSW **Design Sprint** Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation). NI-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. NI-DZO Digital Image Processing Z,ZK This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting. Enterprise Data Warehouse Systems NI-FDW The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowledge not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the area of reporting and data visualization **Embedded Hardware** NI-EHW 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. NI-EPC Effective C++ programming 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 **Experimental Project Course** NI-ESC "The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, methodologies, and tools used in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design projects, collaborate with industry experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills in user-centered design and user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution." **Embedded Software** 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. NI-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. Formal Methods and Specifications Z.ZK 5 Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some software tools that allow to prove basic properties of software. NI-FMT Finite model theory 7.7K The aim of the course is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of logical properties of database systems. Since its inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as descriptive complexity theory, the Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics. NI-GAK Graph theory and combinatorics 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. NI-GEN **Code Generators** 7.7K 5 NI-GLR Z.ZK Games and reinforcement learning 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 **Graph Neural Networks** The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural networks for creating vector representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last part of the course also covers graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems. NI-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. NI-GRI Grid Computing Z,ZK Grid computing and gain knowledge about the world-wide network and computing infrastructure.

NI-HCM Mind Hacking ZK 5 Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, information systems and assets, the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive security is growing in importance in the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet environment have real societal impacts such as disruption of social cohesion, threats to democracy or war. NI-HMI2 History of Mathematics and Informatics This course is presented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms, transformations, recursive functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development. NI-HSC 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 NI-HWB 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. NI-IAM Internet and Multimedia The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquisition of AV signals (input), presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical use case scenarios of real-time audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation NI-IBE Information Security Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international standards in this area. They understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., penetration testing) NI-IKM Internet and Classification Methods In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering, in recommendation systems, in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving these four kinds of problems. On the background of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle with 2-hour lectures and 2-hour exercises. During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult their semester tasks. NI-IOS Advanced techniques in iOS applications Students will learn the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the basics from the beginners class NI-IOT Internet of Things The subject is focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is familiarization with available development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (GNU Forth). NI-IVS Intelligent embedded systems ΚZ Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The course is an advance version of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programming and advance application development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students develop advanced applications combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies NI-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. NI-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. Combinatorial Theories of Games Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria. which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics. Cybernality Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams). Linear Optimization and Methods Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.),

issues from econor	mics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. The in linear programming.	y get orientation ir	algorithms
NI-LSM2	Statistical Modelling Lab	KZ	5
	is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the preser	ce of clutter, or vid	_
NI-MCC	We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli)  Multicore CPU Computing	Z,ZK	5
	rquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on mu		
•	red memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowled	•	
-	ques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and	-	
	On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		
NI-MEP	Modelling of Enterprise Processes	Z,ZK	5
The subject is f	ocused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approa	ch for (re)enginee	ring and
	implementation of processes, organisation structures and information support in big enterprises and institutions.		
NI-MKY	Mathematics for Cryptology	Z,ZK	5
_	deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In		
on the problem o	if solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discre factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on		roblem of
NI-MLP	Machine Learning in Practice	Z,ZK	5
	earning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ide	· '	
	students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically		
_	sing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and		
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
Object-oriented pro	gramming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where	its ability to natura	abstraction
is used to build com	plex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills	s of design and imp	lementation
	in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development n		
•	ing object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work of	٠.,	
	ms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involven		
NI-MPI	Mathematics for Informatics	Z,ZK	7
-	orises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analysation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last top	· ·	
_	stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear pre		
NI-MPL	Managerial Psychology	ZK	2
NI-MPR	Master Project	7	7
	of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial ta	l — — sks that should be	
	er. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the en		
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	s, then, ensure that the assessment is registered into the information system (IS) by asking their internal FT opponent to award the a	ssessment to the I	S based on
	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	-	
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	e upcoming seme	ster should
NII MOI	aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.	7.71/	
NI-MSI	Mathematical Structures in Computer Science mantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scot	Z,ZK	4 calculus
Matrierriatical Se	Introduction to category theory.	i model of lambda	calculus.
NI-MTI	Modern Internet Technologies	Z,ZK	5
	ubject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration	ı '	
	arry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video	•	
integrated services	. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of	of millions of users	and billions
of devices. Thus,	there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and	Traffic Prioritisatio	n - These
	ow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela		tocol). 4.
	eration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in		
NI-MVI	Computational Intelligence Methods	Z,ZK	5
Students will unde	erstand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to m		y wiii learn
NII NAZI	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations,		
NI-MZI	Mathematics for data science entroduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in da	Z,ZK	4 Judied tonics
	near algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ		- 1
o.uuouy	selected notions from probability theory and statistics.	npio, gradioni moti	.ouo, uu
NI-NMU	New media in art and design	ZK	3
	luces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game an		
familiarize the stud	lent with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially	in lectures devoted	to specific
	art projects.		
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
	roduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such method	•	- 1
	inite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They		-
linear algebraic eq	quations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement	these algorithms s	equentially
NI NICO	as well as in parallel.	71/	
NI-NSS	Normalized Software Systems the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering	ZK	5
	from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issu-		-
	second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. The		
	mation systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability	=	
	This knowledge allows students to realize new levels of evolvability in software architectures.		

NI-NUR User Interface Design Z,ZK 5 Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal Uls. Thanks to the gained knowledge, the students will be able to design advanced Uls. Linux Drivers The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining powerful processors and FPGAs increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development for master's students. The course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical experience. Operating Systems and Systems Programming The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel data structures. Key topics are: process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The course also addresses kernel development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. Specifics of kernel architecture in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, students will work on projects focused on development of LINUX kernel modules. NI-PAM Efficient Preprocessing and Parameterized Algorithms Z,ZK 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. NI-PAS Advanced Aspects of Business 4 The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run their own business or business management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspects 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. NI-PDD **Data Preprocessing** Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteristics from images or from web pages. NI-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. NI-PG1 Computer Grafics 1 7K The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientific articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics. NI-PIS **Enterprise Information Systems** The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data (BigData) and their use in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunications sectors will be explained on real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the business strategy of the company. Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation of information systems in the company / organization. NI-PON Selected Topics in Optimization and Numerical mathematics Z,ZK The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-PSD Public Services Design ΚZ The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients. NI-PSI Programming in Scala The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g.pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra, Scalaz, etc. Advanced Virtual Reality NI-PVR The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D models in Blender, and among other things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also deal with creating applications in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the knowledge gained in this subject in virtual reality, or directly create a complex game for VR. NI-PVS Advanced embedded systems Z,ZK 4 The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced topics like security support, working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical experiences with embedded systems.

NI-PYT	Advanced Python	KZ	4
_	urse is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python (I		
ery hands-on and	it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework.	The course is lead	by externa
NII DEV	teachers from Red Hat.	7 71/	
NI-REV	Reverse Engineering	Z,ZK	5
	equainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens befor will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedicat		
	tten in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be decically		
	ebugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer r		
99	the course is on the seminars, where students will solve practically oriented tasks from the real world.		
NI-ROZ	Pattern Recognition	Z,ZK	5
	nodule is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the star		_
	idents will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and		
NI-RUB	Programming in Ruby	KZ	4
'	This course is presented in Czech.		ı
NI-RUN	Runtime Systems	Z,ZK	5
	level of programming languages steadily rises, modern programs require greater and greater support during their runtime. This course in	ntroduces studen	ts to various
spects of the runti	ime support, such as runtime-effective program description, memory management support and garbage collection, just-in-time compila	ation, and interop	erability wit
	other languages and systems.		
NI-SBF	System Security and Forensics	Z,ZK	5
	familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication		
tudents will get fa	miliar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic	analysis techniq	ues and the
	importance of operating system/operating system artifacts or file system for attack analysis and detection).		
NI-SCE1	Computer Engineering Seminar Master I	Z	4
	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to		
* *	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the s	=	
rticles and other p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers	s. The topics are r	new for each
NII 0050	semester.		
NI-SCE2	Computer Engineering Seminar Master II	Ζ	4
	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to		
	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the system of the subject is limited by the possibilities of the compart together.	=	
irticies and other p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers semester.	s. The topics are i	iew ioi eaci
NI SCD	Statistical Analysis of Time Series	7 7K	5
NI-SCR	Statistical Analysis of Time Series	Z,ZK	5 d industrial
The course deals	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices,	employment) an	d industrial
The course deals problems (modellin	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, g of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conven	employment) an ient process mod	d industrial del, estimate
The course deals problems (modelling sparameters, and	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices,	employment) an lient process mod principles based	d industrial del, estimate I on practica
The course deals problems (modellings parameters, and	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, ig of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenilyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main	employment) an lient process mod principles based	d industrial del, estimate I on practica
The course deals problems (modellings parameters, and	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, ig of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenilyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main is. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer	employment) an lient process mod principles based	d industrial del, estimate I on practica
The course deals problems (modellin s parameters, ana eal-world example	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, ag of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conventlyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main is. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer the academic to the real world.	employment) an ident process mod principles based of students' kno Z,ZK	d industrial del, estimate l on practica wledge fron
The course deals problems (modellin s parameters, and eal-world example  NI-SEP This course is p	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, go of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conventlyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main is. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer the academic to the real world.  World Economy and Business	employment) an ident process mod principles based of students' kno Z,ZK technical university.	d industrial del, estimate of the control of the co
The course deals problems (modellings parameters, and eal-world example NI-SEP This course is printernational businecessary for doing	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, ag of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conventilyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main its. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer the academic to the real world.  World Economy and Business  Were sented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of ness. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about differing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the signal of the seconomic freedom, corruption and economic development, which are needed for the signal of the seconomic freedom, corruption and economic development, which are needed for the signal of the seconomic freedom, corruption and economic development, which are needed for the signal of the seconomic freedom, corruption and economic development, which are needed for the signal of the seconomic freedom.	employment) an ident process mod principles based of students' kno Z,ZK technical universement religions and the right investment of the students of the stude	d industrial del, estimate on practica whedge from 4 sity to the d cultures, ent decision
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The course deals roblems (modellin s parameters, and eal-world example  NI-SEP This course is p international businecessary for doing	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, go of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conventive its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main is. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer the academic to the real world.  World Economy and Business  Were sented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of ness. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about differ gousiness in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course in Network Security	employment) an ident process more principles based of students' known and principles based of students' known and principles based of students' known and principles and the right investment religions and the right investment BIE-SEP as a present and present principles.	d industrial del, estimate on practica whedge from 4 sity to the d cultures, ent decision
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synaptic mappings, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transformation into a canonical topology, and in connection with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with training, we pay attention to the problem of overtraining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most important optimization methods employed for neural network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the topic approximation approach to neural networks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Kolmogorov theorem, Vituškin theorem). Afterwards, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings computed by neural networks being dense in important Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to a finite measure, spaces of functions with continuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expectation and training based on a random sample, and with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how it is possible to get an estimate of the conditional expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law of large numbers and get acquainted with an analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the central limit theorem, get acquinted with its analogy for neural networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be employed to search for the topology of the network. Theoretical Seminar Master I NI-TS1 Ζ 4 Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-TS2 Theoretical Seminar Master II Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-TS3 Theoretical Seminar Master III 7 Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-TS4 Theoretical Seminar Master IV Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. NI-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 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. Software Product Development NI-TSW ΚZ The course is presented in Czech. NI-TVR Z.ZK Virtual Reality Technology 3 Students will be introduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD, ...) and the possibilities of controlling virtual avatars (position tracking, hand tracking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of using virtual and augmented reality will be presented. NI-UMI Artificial intelligence Z.ZK 5 The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated. NI-VCC Virtualization and Cloud Computing 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). NI-VMM Retrieval from Multimedia The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines. NI-VOL Elections Z,ZK 5 We will cover the basics of (committee) elections and, in general, opinion aggregation. NI-VPR Ζ Research Project 5 Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en. NI-VSM Selected statistical Methods 7.7K The course leads the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with multivariate normal distribution, application of entropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random processes with focus on Markov chains. The high point of the course is the Queuing theory and its application in networks. NI-VYC Computability Z,ZK 4 Classical theory of recursive functions and effective computability. NI-ZS10 Master internship abroad for 10 credits 7 10 Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship, Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line. Master internship abroad for 20 credits Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with

a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line. NI-ZS30 7 30 Master internship abroad for 30 credits The course is prezented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line. NIE-BLO Blockchain Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platforms. They will be able to design, code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places an increased emphasis on the relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the students for implementing or supervising implementation of blockchain-based solutions in both academia and business. NIE-PDL Practical Deep Learning ΚZ 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-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. PI-SCN Seminars on Digital Design

This subject deals with problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description of digital circuits and basic logic synthesis and optimization algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial problems emerging in EDA.

For updated information see <a href="http://bilakniha.cvut.cz/en/FF.html">http://bilakniha.cvut.cz/en/FF.html</a> Generated: day 2024-05-19, time 20:31.