

# Study plan

## Name of study plan: Aplikace softwarového inženýrství

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Applications of Natural Sciences

Type of study: Follow-up master full-time

Required credits: 105

Elective courses credits: 15

Sum of credits in the plan: 120

Note on the plan:

Name of the block: Compulsory courses of the specialization

Minimal number of credits of the block: 105

The role of the block: PO

Code of the group: NMSASIPP1

Name of the group: NMSASI - povinné p edm ty 1. ro ník

Requirement credits in the group: In this group you have to gain at least 54 credits

Requirement courses in the group: In this group you have to complete at least 13 courses

Credits in the group: 54

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
18AEK	<b>Applied Econometrics and Time Series Theory</b> Jana Sekni ková Jana Sekni ková	Z,ZK	4	2P+2C	Z	PO
18FULS	<b>Fulltext Systems</b> Tomáš Liška Tomáš Liška	KZ	4	2P+2C	L	PO
18MMC	<b>Monte Carlo Method</b> František Gašpar, Miroslav Virius	Z	4	2+2	Z	PO
18MUML	<b>Modeling in UML</b> Vojt ch Merunka Vojt ch Merunka	Z,ZK	4	2+2	L	PO
18MEK	<b>Models and Methods for Economic Decisions</b> Petr Fiala Petr Fiala	Z,ZK	5	2P+2C	Z	PO
18OOP	<b>Object Oriented Programming</b> Miroslav Virius Miroslav Virius	Z	2	2C	Z	PO
01PNM	<b>Advanced Numerical Methods</b> Michal Beneš	KZ	2	2+0	L	PO
18AST	<b>Probability and Applied Statistics</b> Jana Sekni ková	Z,ZK	3	1+1	Z	PO
18REK	<b>Project Management of Economic Systems</b> Petr Fiala Petr Fiala	Z,ZK	4	2P+2C	L	PO
18SOFC	<b>Soft Computing</b> Quang Van Tran, Jaromír Kukul Jaromír Kukul	KZ	4	2+2	Z	PO
18SWI	<b>Software Engineering</b> Vojt ch Merunka	KZ	4	2+2	Z	PO
18VUSE1	<b>Research Project 1</b> Miroslav Virius, Jaromír Kukul, Adam Borovi ka, Ond ej Klimo, Dana Majerová, Josef Nový, Vladimír Jarý, Petr Pauš Miroslav Virius Miroslav Virius (Gar.)	Z	6	0+6	Z	PO
18VUSE2	<b>Research Project 2</b> Miroslav Virius, Adam Borovi ka, Ond ej Klimo, Dana Majerová, Josef Nový, Vladimír Jarý Miroslav Virius Miroslav Virius (Gar.)	KZ	8	0+8	L	PO

### Characteristics of the courses of this group of Study Plan: Code=NMSASIPP1 Name=NMSASI - povinné p edm ty 1. ro ník

18AEK	Applied Econometrics and Time Series Theory	Z,ZK	4
The lectures consist of comments on econometric methods with emphasis on sets of simultaneous linear equations econometric models, time series and vector autoregressive models in economic diagnostics, analysis and forecasting and optimization of economic policy. Case studies and illustrative examples are solved during the practice lessons.			
18FULS	Fulltext Systems	KZ	4
The Fulltext Systems covers methods, algorithms for free text processing including searching and compression methods.			

18MMC	Monte Carlo Method This course is devoted to the numerical method Monte Carlo and to its selected applications.	Z	4
18MUML	Modeling in UML Unified modelling language (UML) is explained from the perspective of the theoretical background of the object-oriented programming and modelling using lambda-calculus. In semestral projects and practical examples, instance-level modeling approach is stressed. This course also brings an introduction into the technology of object-oriented databases and object-oriented data structure querying as the essential tool of modeled system verification and validation.	Z,ZK	4
18MEK	Models and Methods for Economic Decisions The aim of the teaching course is to introduce students to basic models and methods of decision theory. Models are structured according number of participants, number of criteria, sets of decision variants, and other attributes. Included basic disciplines are decision by certainty, risk and uncertainty, multicriteria decision-making, and group decision-making.	Z,ZK	5
18OOP	Object Oriented Programming This course consists of the contributions of students concerning given topics concerned on technologies used in program development.	Z	2
01PNM	Advanced Numerical Methods The course is devoted to advanced numerical solution of boundary-value problems and initial-boundary-value problems for ordinary and partial differential equations. It explains the shooting method, advanced finite-difference methods and finite-volume method for nonlinear elliptic, parabolic and first-order hyperbolic partial differential equations.	KZ	2
18AST	Probability and Applied Statistics The lecture links to previous analogue courses with significant emphasis of relationship between mathematical models and practical application and warrant of inevitability of this relationship	Z,ZK	3
18REK	Project Management of Economic Systems The aim of the teaching course is to introduce students to basic techniques of project management. Project is used as a standard instrument for result achievement within given time period, given budget and disposable resources. During lessons students will be introduced to using of Microsoft Project.	Z,ZK	4
18SOFC	Soft Computing Fuzzy systems and selected artificial neural networks are discussed as special cases of Lipschitz continuous functions with constrained sensitivity and limited output. Both theories and application conventions are included.	KZ	4
18SWI	Software Engineering The course explains essential software engineering techniques of the complex software system building using object-oriented programming. The software development process is explained as an integration of system development, software quality assurance, and software project management using miscellaneous techniques. Moreover, programming language Smalltalk is used as a demonstration tool for explained tools and techniques.	KZ	4
18VUSE1	Research Project 1 The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.	Z	6
18VUSE2	Research Project 2 The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.	KZ	8

Code of the group: NMSASIPP2

Name of the group: NMSASI - povinné p edm ty 2. ro ník

Requirement credits in the group: In this group you have to gain at least 51 credits

Requirement courses in the group: In this group you have to complete at least 9 courses

Credits in the group: 51

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
18DPSE1	<b>Master Thesis 1</b> Tomáš Liška, Miroslav Virius, Jaromír Kukul, Dana Majerová, Vladimír Jarý, Adam Novozámský, Martin Plajner, Jiří Vomlel, Tomáš Oberhuber, ..... <b>Vladimír Jarý</b> Miroslav Virius (Gar.)	Z	10	0+10	Z	PO
18DPSE2	<b>Master Thesis 2</b> Jana Sekníková, Tomáš Liška, Miroslav Virius, Jaromír Kukul, Dana Majerová, Vladimír Jarý, Adam Novozámský, Martin Plajner, Jiří Vomlel, ..... <b>Kateřina Horaisová</b> Miroslav Virius (Gar.)	Z	20	0+20	L	PO
18HEUR	<b>Heuristic Algorithms</b> Jaromír Kukul, Matej Mojzeš <b>Jaromír Kukul</b>	KZ	4	2+2	L	PO
18MOPR	<b>Modeling of Production Systems in Economy</b> Adam Borovička	Z,ZK	5	2+2	Z	PO
18SDI1	<b>Diploma Seminar 1</b> Miroslav Virius	Z	2	0+2	Z	PO
18SDI2	<b>Diploma Seminar 2</b> Miroslav Virius <b>Miroslav Virius</b> Miroslav Virius (Gar.)	Z	3	0+2	L	PO
18SROZ	<b>Statistical Pattern Recognition and Decision Making Methods</b> Jaromír Kukul	ZK	3	2+0	Z	PO
01VAMB	<b>Variational Methods B</b> Michal Beneš <b>Michal Beneš</b> Michal Beneš (Gar.)	KZ	2	2	Z	PO
18ZTI	<b>Background of Information Theory</b> Jaromír Kukul	KZ	2	2+0	L	PO

Characteristics of the courses of this group of Study Plan: Code=NMSASIPP2 Name=NMSASI - povinné p edm ty 2. ro ník

18DPSE1	Master Thesis 1 The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions	Z	10
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18DPSE2	Master Thesis 2	Z	20
The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
18HEUR	Heuristic Algorithms	KZ	4
Heuristic algorithms of optimization operates on discrete or continuous domains. Brutal force, stochastic, greedy, physically, biologically and sociologically motivated heuristic are included, used for optimum finding and compared.			
18MOPR	Modeling of Production Systems in Economy	Z,ZK	5
The aim of the teaching course is to introduce students to basic models and methods for analysis and optimization of production systems. Models are oriented on design, operation, measurement and improvement phases of production systems. Models and analyses of supply chains are considered also. Model formulations are based on integer programming a graph theory. Optimization and heuristic approaches are used for solutions.			
18SDI1	Diploma Seminar 1	Z	2
Seminar devoted to preparation of the diploma thesis and the presentation of the result. Students present their running results.			
18SDI2	Diploma Seminar 2	Z	3
In the first part of the seminar, students familiarize themselves with the general principles of publishing and presenting scientific work and the formal requirements for diploma projects at the faculty. The second part is designed as a practical training for the defence of the diploma project. The students give oral presentations of the current state of the research results achieved during the work on their projects. Each presentation is followed by a discussion on scientific matters as well as on the possibilities of improving the student's performance.			
18SROZ	Statistical Pattern Recognition and Decision Making Methods	ZK	3
Collection of recognition and classification methods with accent to mathematical and statistical principles of their design and functionality.			
01VAMB	Variational Methods B	KZ	2
The course is devoted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or monotonicity. Further, it contains investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.			
18ZTI	Background of Information Theory	KZ	2
Entropy as a measure of uncertainty and its use to measure the amount of information. Possibilities of use of information access in various fields of science, engineering economics, etc. to solve specific 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: NMSASIVP

Name of the group: NMSASI - volitelné p edm ty

Requirement credits in the group:

Requirement courses in the group:

Credits in the group: 0

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) <i>Tutors, authors and guarantors (gar.)</i>	Completion	Credits	Scope	Semester	Role
18AMTL	<b>Matlab Applications</b> <i>František Gašpar, Quang Van Tran, Jaromír Kukal Jaromír Kukal Jaromír Kukal (Gar.)</i>	KZ	4	2P+2C	L	v
18SQL	<b>SQL Applications</b> <i>Jaromír Kukal, Dana Majerová Dana Majerová Jaromír Kukal (Gar.)</i>	Z	2	0+2	Z	v
18BI	<b>Business Intelligence</b> <i>Matej Moješ Matej Moješ</i>	KZ	2	1P+1C	Z	v
18DWH	<b>Data Warehouse Systems, Big Data Processing</b>	ZK	4	2+2	L	v
18DATS	<b>Database System Decomposition</b> <i>Jaromír Kukal</i>	KZ	4	2+2	L	v
01DYRO	<b>Dynamic Decision Making</b>	ZK	4	3+1		v
01DRO1	<b>Dynamic Decision Making 1</b>	ZK	2	2+0		v
01FIMA	<b>Financial and Insurance Mathematics</b> <i>Joel Horowitz Joel Horowitz Joel Horowitz (Gar.)</i>	ZK	2	2P+0C	Z	v
01JAA	<b>Languages and Automata</b>	ZK	2	2+0	L	v
01JAVY	<b>Languages, Automata and Computability</b>	Z,ZK	5	3+1		v
01JAV	<b>Languages, automata, and computability</b>	Z,ZK	4	3+1		v
01MRM	<b>Methods for Sparse Matrices</b>	ZK	2	2+0	L	v
18MRSS	<b>Modeling and Control of Continuous Systems</b> <i>Jaromír Kukal</i>	KZ	4	2+2	Z	v
01SMF	<b>Modern Trends in Corporate Information Technologies</b> <i>Tomáš Oberhuber Tomáš Oberhuber Tomáš Oberhuber (Gar.)</i>	Z	2	2	L	v
01NELI	<b>Nonlinear Programming</b>	ZK	4	3P+0C	Z	v
01PAA	<b>Parallel Algorithms and Architectures</b> <i>Tomáš Oberhuber Tomáš Oberhuber Tomáš Oberhuber (Gar.)</i>	KZ	4	2P+1C	L	v
18UIA2	<b>Advanced Algorithms 2</b> <i>Vladimír Jarý Vladimír Jarý</i>	Z	2	1P+1C	L	v

01PNLA	<b>Advanced Methods of Numerical Linear Algebra</b>	ZK	3	2+0	Z	v
18PCP	<b>Advanced C++</b> <i>Miroslav Vrius Miroslav Vrius</i>	Z,ZK	4	2P+2C		v
01PMU	<b>Probabilistic Learning Models</b> <i>František Hák František Hák František Hák (Gar.)</i>	ZK	2	2+0	Z	v
01PMF	<b>Mainframe Programming</b> <i>Tomáš Oberhuber Tomáš Oberhuber Tomáš Oberhuber (Gar.)</i>	Z	2	2	L	v
18NET	<b>Programming for the .NET Framework</b> <i>Miroslav Vrius Miroslav Vrius</i>	Z,ZK	2	1P+1C	Z	v
18PVS	<b>Industrial Software Development</b> <i>Jan Doubek</i>	Z	2	1+1	Z	v
18RFP	<b>Resolution of Physical Issues</b> <i>Jiří Konfršt Jiří Konfršt</i>	KZ	3	1P+2C	L	v
18RDS	<b>Control of Discrete Systems</b>	KZ	4	2+2	L	v
01SWPR1	<b>Software Project 1</b>	Z	2	0+2		v
01SWPR2	<b>Software Project 2</b>	Z	2	0+2		v
01TC	<b>Number Theory</b>	ZK	4	2+0	L	v
18TFT	<b>Financial Markets Theory</b> <i>Quang Van Tran, Nichita Vatamaniuc Quang Van Tran</i>	KZ	4	2P+2C	Z	v
01NAH	<b>Theory of Random Processes</b> <i>Jan Vybíral Jan Vybíral Jan Vybíral (Gar.)</i>	ZK	3	3+0	Z	v
01TSLO	<b>Complexity Theory</b> <i>Jan Volec Jan Volec Jan Volec (Gar.)</i>	ZK	3	3+0	Z	v
18DSJ	<b>Design of Domain Specific Languages</b>	KZ	2	1+1		v
18DTJ	<b>Design of Domain Specific Languages</b>	Z	2	1+1	Z	v
01UMF	<b>Introduction to Mainframe</b> <i>Tomáš Oberhuber Tomáš Oberhuber Tomáš Oberhuber (Gar.)</i>	Z	2	1P+1C	Z	v
12UM	<b>Introduction to Management</b> <i>Petr Malát Petr Malát Petr Malát (Gar.)</i>	ZK	2	2+0	Z	v
18UIA1	<b>Introduction to Advanced Algorithms</b> <i>Vladimír Jarý Vladimír Jarý</i>	Z	2	1P+1C	Z	v
01ZPB1	<b>Introduction to Computer Security 1</b> <i>Petr Voká Petr Voká Petr Voká (Gar.)</i>	Z	2	1+1		v
01ZPB2	<b>Introduction to Computer Security 2</b> <i>Petr Voká Petr Voká Petr Voká (Gar.)</i>	Z	2	1+1		v
18ZPS	<b>Primer of Computer Simulations</b>	Z	4	2+2	L	v
01ZTG	<b>Introduction to Graph Theory</b>	ZK	4	4+0		v
01ROZ1	<b>Image Processing and Pattern Recognition 1</b>	ZK	4	2+2	L	v
18ZDFT	<b>Financial Markets Data Processing</b> <i>Quang Van Tran Quang Van Tran</i>	KZ	4	2P+2C	L	v

#### Characteristics of the courses of this group of Study Plan: Code=NMSASIVP Name=NMSASI - volitelné p edm ty

18AMTL	Matlab Applications	KZ	4	Systematic application of Matlab optimization toolbox for the solution of linear, quadratic, binary, integer an nonlinear programming tasks. Simulation of chaotic systems an fractal set generation. Analysis of trajectories, attractors and fractal sets including estimation of their properties.		
18SQL	SQL Applications	Z	2	Practical realization of database system according to general principles of database analysis.		
18BI	Business Intelligence	KZ	2	The aim of the subject is to explain to the students different characteristics of production and analytical databases and a set of processes, know-how and tools (not only) to support decision-making activities within the organization. In addition to the basic concept of BI, listeners will get acquainted with the general methodology of implementation of custom algorithms derived from other theories and subjects into the BI environment.		
18DWH	Data Warehouse Systems, Big Data Processing	ZK	4	The data warehouse architecture, implementation, methods for extraction of the data from various sources, transformation procedures and loading as well as data processing, archiving, data searching and evaluating are deeply studied in these lectures.		
18DATS	Database System Decomposition	KZ	4	The lectures are oriented to basic terms, database objects, their properties and relationships together with the accent to logics of decomposition and applications of database operations.		
01DYRO	Dynamic Decision Making	ZK	4			
01DRO1	Dynamic Decision Making 1	ZK	2	Design, control and analysis of intelligent agents (or systems) that behave appropriately in various circumstances are highly demanded (artificial intelligence and machine learning, data mining, financial modelling, natural language processing, bioinformatics, web search and information retrieval, algorithm design, system design, network analysis, and more). Such intelligent agents need to reason with uncertain information and limited computational resources. Effective decision making requires the knowledge about: . the agent's environment and its dynamics (including the presence of other intelligent agents), . the agent's goals and preferences . the agent's abilities to observe and influence the environment. This course introduces dynamic decision making under uncertainty and computational methods supporting decision-making. The course helps to develop the mathematical reasoning skills crucial for areas inherently involving uncertainty. These skills can serve as the foundation for further study in any application area you choose to pursue and may also help you to analyse the uncertainty in your everyday life. Course objectives: - Learn the basic ideas and techniques underlying design of intelligent rational agents. A specific emphasis will be on the decision-theoretic modelling paradigm. - Understand state-of-the-art of decision making (DM). - Be able to formulate decision making or learning problem and select appropriate method for a given task/application. - Be able to understand research papers in the field (main conferences: IJCAI, NIPS, AAMAS, ICAART, ICM; main journals: AI, JAIR, JAAMAS, IJAR). - Try out some ideas of your own.		
01FIMA	Financial and Insurance Mathematics	ZK	2	This course is an introduction to the problems of life and non-life insurance and financial mathematics.		

01JAA	Languages and Automata Various types of generative grammars and corresponding automata. Closure and algorithmic problems.	ZK	2
01JAVY	Languages, Automata and Computability Finite automata and regular languages. Context free languages and pushdown automata. Unrestricted languages and Turing machines. Algorithms a algorithmically enumerable functions. Recursive functions, recursive sets and recursively enumerable sets. Algorithmically unsolvable problems.	Z,ZK	5
01JAV	Languages, automata, and computability Finite automata and regular languages. Context free languages and pushdown automata. Unrestricted languages and Turing machines. Algorithms a algorithmically enumerable functions. Recursive functions, recursive sets and recursively enumerable sets. Algorithmically unsolvable problems.	Z,ZK	4
01MRM	Methods for Sparse Matrices The course is aimed at utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will cover the decomposition theory for symmetric and positive definite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods and common implementation issues will be covered.	ZK	2
18MRSS	Modeling and Control of Continuous Systems	KZ	4
01SMF	Modern Trends in Corporate Information Technologies The course is devoted to mainframe administration basics. After introduction to mainframe hardware the following lectures covers security, transaction systems, virtualization and non-relational databases in the mainframe environment.	Z	2
01NELI	Nonlinear Programming Nonlinear optimization problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programming theory with emphasis on convex optimization and basic methods for unconstrained and constrained optimization. The lecture is supplemented by illustrative examples.	ZK	4
01PAA	Parallel Algorithms and Architectures This course deals with the parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish given task in reasonable time. When designing parallel algorithms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part of this course too.	KZ	4
18UIA2	Advanced Algorithms 2 The lecture covers selected algorithms of the artificial intelligence and construction of autonomous robot.	Z	2
01PNLA	Advanced Methods of Numerical Linear Algebra Representation of real numbers in computers, behaviour of rounding errors during numerical computations, sensitivity of a problem, numerical stability of an algorithm. We will analyse sensitivity of the eigenvalues of a given matrix and sensitivity of roots of systems of linear algebraic equations. Then, the backward analysis of these problems will be performed. The second part of the course is devoted to the methods of QR-decomposition, least squares problem, and to several modern Krylov subspace methods for the solution of systems of linear algebraic equations and the Lanczos method for approximation of the eigenvalues of a symmetric square matrix.	ZK	3
18PCP	Advanced C++ This lecture covers the virtual inheritance, variadic templates, template metaprogramming, template libraries design and implementation, tools for data type processing in compile time and for the advanced diagnostic of the templates, application of the multithreading (execution parallelization), treating the locales (localization and internationalization of the software), the tools for advanced mathematical and technical computing and the file system access tools.	Z,ZK	4
01PMU	Probabilistic Learning Models Introduction into the theory PAC learning model, VC-dimension of finite sets, Sauer, Cover and Radon's lemma, VC-dimension of composed mappings, application of VC-dimension for lower bound of necessary patterns, analysis of properties of delta rule based learning processes, PAC learning model extensions and PAO learning, Fourier coefficients search for Boolean functions.	ZK	2
01PMF	Mainframe Programming In this course the basics of programming in z/OS are explained namely the programming in assembler. Basic instructions, macros, I/O operations, DLL library loading and some other topics are discussed.	Z	2
18NET	Programming for the .NET Framework This course is devoted to the principles of the .NET Framework and to the programming of the common applications for .NET Framework. It is based on the C# programming language.	Z,ZK	2
18PVS	Industrial Software Development General lecture about applied code writing in commercial sphere. All essential programmer skills associated with development of software for industrial purposes will be covered during the lecture. This includes versioning, testing, release handling and also code quality measurement. The simple real world use scenarios introduced in lectures will be deeply examined in examples. The examples will be constructed with emphasis on understanding and reuse of already done third person code.	Z	2
18RFP	Resolution of Physical Issues There are various specific problems having physical background (for example also in forensic medicine or biomechanics) in maybe all technology disciplines and also in majority of natural sciences (related both to living and non-living matter). Their solution is not often easy feasible in analytic way, but it is required from perspective of its understanding and appreciation. Hence this subject is focused at some more complex issues, which solvability is based on acceptable simplification for subsequent possible computer processing regardless it is mathematical, geometrical, material of other conceivable simplification. This subject prefers analytical way of solution, but there is obvious required link to software engineering methods. Software engineering is the only way how to realize the solution. In conclusion, this subject will instruct students, how to transform selected physical issue using both numerical and analytical methods from its insolvable state to a solvable state having acceptable accuracy	KZ	3
18RDS	Control of Discrete Systems	KZ	4
01SWPR1	Software Project 1	Z	2
01SWPR2	Software Project 2	Z	2
01TC	Number Theory The subject is devoted to number theory with focus on continued fractions and fundamentals of algebraic number theory.	ZK	4
18TFT	Financial Markets Theory Since financial instrument prices are unknown in advance to financial market participants, financial derivatives are currently being used as common instruments to eliminate risks arising from price instability of financial assets. The theory of financial markets uses the knowledge of mathematical analysis and statistics to manage the portfolio of risk assets and the valuation of sophisticated financial instruments in the form of derivatives such as swaps, forwards, futures and options.	KZ	4
01NAH	Theory of Random Processes The course is devoted in part to the basic notions of the general theory of random processes and partially to the theory of stationary processes and sequences both weakly and strongly stationary ones.	ZK	3
01TSLO	Complexity Theory The course is devoted to incorporation of complexity questions during algorithm development, introduction to NP completeness and generally to complexity classes of deterministic or nondeterministic Turing machines bounded by time or space. Emphasis is placed on mutual relations among these classes. Aside from nondeterministic classes we examine probability classes. Class of interactive protocols is presented at the end of lecture course.	ZK	3
18DSJ	Design of Domain Specific Languages	KZ	2
18DTJ	Design of Domain Specific Languages	Z	2

01UMF	Introduction to Mainframe	Z	2
In this course we teach the mainframe architecture. We explain how to operate the system z/OS, how to start a job using the JCL and we explain some differences when programming in C/C++ for z/OS.			
12UM	Introduction to Management	ZK	2
Modern management conception, managerial functions, managerial activities . Managerial decision tasks, business strategy. Human resources management, Staff motivation and evaluation, teamwork, labour code. System marketing conception, marketing goals, marketing strategy. Marketing planning and decision making. Marketing mix, product life cycle, publicity campaign.			
18UIA1	Introduction to Advanced Algorithms	Z	2
The lecture covers selected algorithms of the artificial intelligence and their application in the real world.			
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2
18ZPS	Primer of Computer Simulations	Z	4
01ZTG	Introduction to Graph Theory	ZK	4
01ROZ1	Image Processing and Pattern Recognition 1	ZK	4
An introductory course on image processing and pattern recognition. Major attention is paid to image sampling and quantization, image preprocessing (noise removal, contrast stretching, sharpening, and de-blurring, Wiener filtering, blind deconvolution), edge detection, morphology and geometric transformations and warping. Numerous applications and experimental results are presented in addition to the theory.			
18ZDFT	Financial Markets Data Processing	KZ	4
The course enables students to combine knowledge of numerical methods, Matlab programming and financial mathematics to solve practical problems in finance such as portfolio optimization, risk management and valuation of financial derivatives, especially options of different types. Upon completion of the course the student will be able to formulate and numerically solve concrete problems in the given field and subsequently implement their solutions in practice.			

### List of courses of this pass:

Code	Name of the course	Completion	Credits
01DRO1	Dynamic Decision Making 1	ZK	2
Design, control and analysis of intelligent agents (or systems) that behave appropriately in various circumstances are highly demanded (artificial intelligence and machine learning, data mining, financial modelling, natural language processing, bioinformatics, web search and information retrieval, algorithm design, system design, network analysis, and more). Such intelligent agents need to reason with uncertain information and limited computational resources. Effective decision making requires the knowledge about: . the agent's environment and its dynamics (including the presence of other intelligent agents), . the agent's goals and preferences . the agent's abilities to observe and influence the environment. This course introduces dynamic decision making under uncertainty and computational methods supporting decision-making. The course helps to develop the mathematical reasoning skills crucial for areas inherently involving uncertainty. These skills can serve as the foundation for further study in any application area you choose to pursue and may also help you to analyse the uncertainty in your everyday life. Course objectives: - Learn the basic ideas and techniques underlying design of intelligent rational agents. A specific emphasis will be on the decision-theoretic modelling paradigm. - Understand state-of-the-art of decision making (DM). - Be able to formulate decision making or learning problem and select appropriate method for a given task/application. - Be able to understand research papers in the field (main conferences: IJCAI, NIPS, AAMAS, ICAART, ICM; main journals: AI, JAIR, JAAMAS, IJAR). - Try out some ideas of your own.			
01DYRO	Dynamic Decision Making	ZK	4
01FIMA	Financial and Insurance Mathematics	ZK	2
This course is an introduction to the problems of life and non-life insurance and financial mathematics.			
01JAA	Languages and Automata	ZK	2
Various types of generative grammars and corresponding automata. Closure and algorithmic problems.			
01JAV	Languages, automata, and computability	Z,ZK	4
Finite automata and regular languages. Context free languages and pushdown automata. Unrestricted languages and Turing machines. Algorithms a algorithmically enumerable functions. Recursive functions, recursive sets and recursively enumerable sets. Algorithmically unsolvable problems.			
01JAVY	Languages, Automata and Computability	Z,ZK	5
Finite automata and regular languages. Context free languages and pushdown automata. Unrestricted languages and Turing machines. Algorithms a algorithmically enumerable functions. Recursive functions, recursive sets and recursively enumerable sets. Algorithmically unsolvable problems.			
01MRM	Methods for Sparse Matrices	ZK	2
The course is aimed at utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will cover the decomposition theory for symmetric and positive definite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods and common implementation issues will be covered.			
01NAH	Theory of Random Processes	ZK	3
The course is devoted in part to the basic notions of the general theory of random processes and partially to the theory of stationary processes and sequences both weakly and strongly stationary ones.			
01NELI	Nonlinear Programming	ZK	4
Nonlinear optimization problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programming theory with emphasis on convex optimization and basic methods for unconstrained and constrained optimization. The lecture is supplemented by illustrative examples.			
01PAA	Parallel Algorithms and Architectures	KZ	4
This course deals with the parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish given task in reasonable time. When designing parallel algorithms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part of this course too.			
01PMF	Mainframe Programming	Z	2
In this course the basics of programming in z/OS are explained namely the programming in assembler. Basic instructions, macros, I/O operations, DLL library loading and some other topics are discussed.			

01PMU	Probabilistic Learning Models	ZK	2
Introduction into the theory PAC learning model, VC-dimension of finite sets, Sauer, Cover and Radon's lemma, VC-dimension of composed mappings, application of VC-dimension for lower bound of necessary patterns, analysis of properties of delta rule based learning processes, PAC learning model extensions and PAO learning, Fourier coefficients search for Boolean functions.			
01PNLA	Advanced Methods of Numerical Linear Algebra	ZK	3
Representation of real numbers in computers, behaviour of rounding errors during numerical computations, sensitivity of a problem, numerical stability of an algorithm. We will analyse sensitivity of the eigenvalues of a given matrix and sensitivity of roots of systems of linear algebraic equations. Then, the backward analysis of these problems will be performed. The second part of the course is devoted to the methods of QR-decomposition, least squares problem, and to several modern Krylov subspace methods for the solution of systems of linear algebraic equations and the Lanczos method for approximation of the eigenvalues of a symmetric square matrix.			
01PNM	Advanced Numerical Methods	KZ	2
The course is devoted to advanced numerical solution of boundary-value problems and initial-boundary-value problems for ordinary and partial differential equations. It explains the shooting method, advanced finite-difference methods and finite-volume method for nonlinear elliptic, parabolic and first-order hyperbolic partial differential equations.			
01ROZ1	Image Processing and Pattern Recognition 1	ZK	4
An introductory course on image processing and pattern recognition. Major attention is paid to image sampling and quantization, image preprocessing (noise removal, contrast stretching, sharpening, and de-blurring, Wiener filtering, blind deconvolution), edge detection, morphology and geometric transformations and warping. Numerous applications and experimental results are presented in addition to the theory.			
01SMF	Modern Trends in Corporate Information Technologies	Z	2
The course is devoted to mainframe administration basics. After introduction to mainframe hardware the following lectures covers security, transaction systems, virtualization and non-relational databases in the mainframe environment.			
01SWPR1	Software Project 1	Z	2
01SWPR2	Software Project 2	Z	2
01TC	Number Theory	ZK	4
The subject is devoted to number theory with focus on continued fractions and fundamentals of algebraic number theory.			
01TSLO	Complexity Theory	ZK	3
The course is devoted to incorporation of complexity questions during algorithm development, introduction to NP completeness and generally to complexity classes of deterministic or nondeterministic Turing machines bounded by time or space. Emphasis is placed on mutual relations among these classes. Aside from nondeterministic classes we examine probability classes. Class of interactive protocols is presented at the end of lecture course.			
01UMF	Introduction to Mainframe	Z	2
In this course we teach the mainframe architecture. We explain how to operate the system z/OS, how to start a job using the JCL and we explain some differences when programming in C/C++ for z/OS:			
01VAMB	Variational Methods B	KZ	2
The course is devoted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or monotonicity. Further, it contains investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.			
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2
01ZTG	Introduction to Graph Theory	ZK	4
12UM	Introduction to Management	ZK	2
Modern management conception, managerial functions, managerial activities. Managerial decision tasks, business strategy. Human resources management, Staff motivation and evaluation, teamwork, labour code. System marketing conception, marketing goals, marketing strategy. Marketing planning and decision making. Marketing mix, product life cycle, publicity campaign.			
18AEK	Applied Econometrics and Time Series Theory	Z,ZK	4
The lectures consist of comments on econometric methods with emphasis on sets of simultaneous linear equations econometric models, time series and vector autoregressive models in economic diagnostics, analysis and forecasting and optimization of economic policy. Case studies and illustrative examples are solved during the practice lessons.			
18AMTL	Matlab Applications	KZ	4
Systematic application of Matlab optimization toolbox for the solution of linear, quadratic, binary, integer nonlinear programming tasks. Simulation of chaotic systems and fractal set generation. Analysis of trajectories, attractors and fractal sets including estimation of their properties.			
18AST	Probability and Applied Statistics	Z,ZK	3
The lecture links to previous analogue courses with significant emphasis of relationship between mathematical models and practical application and warrant of inevitability of this relationship			
18BI	Business Intelligence	KZ	2
The aim of the subject is to explain to the students different characteristics of production and analytical databases and a set of processes, know-how and tools (not only) to support decision-making activities within the organization. In addition to the basic concept of BI, listeners will get acquainted with the general methodology of implementation of custom algorithms derived from other theories and subjects into the BI environment.			
18DATS	Database System Decomposition	KZ	4
The lectures are oriented to basic terms, database objects, their properties and relationships together with the accent to logics of decomposition and applications of database operations.			
18DPSE1	Master Thesis 1	Z	10
The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions			
18DPSE2	Master Thesis 2	Z	20
The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
18DSJ	Design of Domain Specific Languages	KZ	2
18DTJ	Design of Domain Specific Languages	Z	2
18DWH	Data Warehouse Systems, Big Data Processing	ZK	4
The data warehouse architecture, implementation, methods for extraction of the data from various sources, transformation procedures and loading as well as data processing, archiving, data searching and evaluating are deeply studied in these lectures.			
18FULS	Fulltext Systems	KZ	4
The Fulltext Systems covers methods, algorithms for free text processing including searching and compression methods.			

18HEUR	<b>Heuristic Algorithms</b> Heuristic algorithms of optimization operates on discrete or continuous domains. Brutal force, stochastic, greedy, physically, biologically and sociologically motivated heuristic are included, used for optimum finding and compared.	KZ	4
18MEK	<b>Models and Methods for Economic Decisions</b> The aim of the teaching course is to introduce students to basic models and methods of decision theory. Models are structured according number of participants, number of criteria, sets of decision variants, and other attributes. Included basic disciplines are decision by certainty, risk and uncertainty, multicriteria decision-making, and group decision-making.	Z,ZK	5
18MMC	<b>Monte Carlo Method</b> This course is devoted to the numerical method Monte Carlo and to its selected applications.	Z	4
18MOPR	<b>Modeling of Production Systems in Economy</b> The aim of the teaching course is to introduce students to basic models and methods for analysis and optimization of production systems. Models are oriented on design, operation, measurement and improvement phases of production systems. Models and analyses of supply chains are considered also. Model formulations are based on integer programming a graph theory. Optimization and heuristic approaches are used for solutions.	Z,ZK	5
18MRSS	<b>Modeling and Control of Continuous Systems</b>	KZ	4
18MUML	<b>Modeling in UML</b> Unified modelling language (UML) is explained from the perspective of the theoretical background of the object-oriented programming and modelling using lambda-calculus. In semestral projects and practical examples, instance-level modeling approach is stressed. This course also brings an introduction into the technology of object-oriented databases and object-oriented data structure querying as the essential tool of modeled system verification and validation.	Z,ZK	4
18NET	<b>Programming for the .NET Framework</b> This course is devoted to the principles of the .NET Framework and to the programming of the common applications for .NET Framework. It is based on the C# programming language.	Z,ZK	2
18OOP	<b>Object Oriented Programming</b> This course consists of the contributions of students concerning given topics concerned on technologies used in program development.	Z	2
18PCP	<b>Advanced C++</b> This lecture covers the virtual inheritance, variadic templates, template metaprogramming, template libraries design and implementation, tools for data type processing in compile time and for the advanced diagnostic of the templates, application of the multithreading (execution parallelization), treating the locales (localization and internationalization of the software), the tools for advanced mathematical and technical computing and the file system access tools.	Z,ZK	4
18PVS	<b>Industrial Software Development</b> General lecture about applied code writing in commercial sphere. All essential programmer skills associated with development of software for industrial purposes will be covered during the lecture. This includes versioning, testing, release handling and also code quality measurement. The simple real world use scenarios introduced in lectures will be deeply examined in examples. The examples will be constructed with emphasis on understanding and reuse of already done third person code.	Z	2
18RDS	<b>Control of Discrete Systems</b>	KZ	4
18REK	<b>Project Management of Economic Systems</b> The aim of the teaching course is to introduce students to basic techniques of project management. Project is used as a standard instrument for result achievement within given time period, given budget and disposable resources. During lessons students will introduced to using of Microsoft Project.	Z,ZK	4
18RFP	<b>Resolution of Physical Issues</b> There are various specific problems having physical background (for example also in forensic medicine or biomechanics) in maybe all technology disciplines and also in majority of natural sciences (related both to living and non-living matter). Their solution is not often easy feasible in analytic way, but it is required from perspective of its understanding and appreciation. Hence this subject is focused at some more complex issues, which solvability is based on acceptable simplification for subsequent possible computer processing regardless it is mathematical, geometrical, material of other conceivable simplification. This subject prefers analytical way of solution, but there is obvious required link to software engineering methods. Software engineering is the only way how to realize the solution. In conclusion, this subject will instruct students, how to transform selected physical issue using both numerical and analytical methods from its insolvable state to a solvable state having acceptable accuracy	KZ	3
18SDI1	<b>Diploma Seminar 1</b> Seminar devoted to preparation of the diploma thesis and the presentation of the result. Students present their running results.	Z	2
18SDI2	<b>Diploma Seminar 2</b> In the first part of the seminar, students familiarize themselves with the general principles of publishing and presenting scientific work and the formal requirements for diploma projects at the faculty. The second part is designed as a practical training for the defence of the diploma project. The students give oral presentations of the current state of the research results achieved during the work on their projects. Each presentation is followed by a discussion on scientific matters as well as on the possibilities of improving the student's performance.	Z	3
18SOFC	<b>Soft Computing</b> Fuzzy systems and selected artificial neural networks are discussed as special cases of Lipschitz continuous functions with constrained sensitivity and limited output. Both theories and application conventions are included.	KZ	4
18SQL	<b>SQL Applications</b> Practical realization of database system according to general principles of database analysis.	Z	2
18SROZ	<b>Statistical Pattern Recognition and Decision Making Methods</b> Collection of recognition and classification methods with accent to mathematical and statistical principles of their design and functionality.	ZK	3
18SWI	<b>Software Engineering</b> The course explains essential software engineering techniques of the complex software system building using object-oriented programming. The software development process is explained as an integration of system development, software quality assurance, and software project management using miscellaneous techniques. Moreover, programming language Smalltalk is used as a demonstration tool for explained tools and techniques.	KZ	4
18TFT	<b>Financial Markets Theory</b> Since financial instrument prices are unknown in advance to financial market participants, financial derivatives are currently being used as common instruments to eliminate risks arising from price instability of financial assets. The theory of financial markets uses the knowledge of mathematical analysis and statistics to manage the portfolio of risk assets and the valuation of sophisticated financial instruments in the form of derivatives such as swaps, forwards, futures and options.	KZ	4
18UIA1	<b>Introduction to Advanced Algorithms</b> The lecture covers selected algorithms of the artificial intelligence and their application in the real world.	Z	2
18UIA2	<b>Advanced Algorithms 2</b> The lecture covers selected algorithms of the artificial intelligence and construction of autonomous robot.	Z	2
18VUSE1	<b>Research Project 1</b> The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.	Z	6
18VUSE2	<b>Research Project 2</b> The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.	KZ	8



18ZDFT	Financial Markets Data Processing	KZ	4
The course enables students to combine knowledge of numerical methods, Matlab programming and financial mathematics to solve practical problems in finance such as portfolio optimization, risk management and valuation of financial derivatives, especially options of different types. Upon completion of the course the student will be able to formulate and numerically solve concrete problems in the given field and subsequently implement their solutions in practice.			
18ZPS	Primer of Computer Simulations	Z	4
18ZTI	Background of Information Theory	KZ	2
Entropy as a measure of uncertainty and its use to measure the amount of information. Possibilities of use of information access in various fields of science, engineering economics, etc. to solve specific problems.			

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

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