Study plan

Name of study plan: Matematické inženýrství

Faculty/Institute/Others: Department: Branch of study guaranteed by the department: Welcome page Garantor of the study branch: Program of study: Mathematical Engineering Type of study: Follow-up master full-time Required credits: 8 Elective courses credits: 112 Sum of credits in the plan: 120 Note on the plan:

Name of the block: Compulsory courses in the program Minimal number of credits of the block: 0 The role of the block: P

Code of the group: NMSPMI1 Name of the group: MDP P_MIN 1st year Requirement credits in the group: Requirement courses in the group: In this group you have to complete at least 11 courses Credits in the group: 0

Note on the group: 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 Scope Semester members) Tutors, authors and guarantors (gar.) **Functional Analysis 3** 01FAN3 Z.ZK 5 2P+2C 7 Pavel Š oví ek Pavel Š oví ek (Gar.) **Mathematical Methods in Fluid Dynamics 1** Ζ 01MMDY ΖK 2 2P+0C Pavel Strachota Pavel Strachota Pavel Strachota (Gar.) **Finite Element Method** 01MKP 3 1P+1C L ΖK Michal Beneš Michal Beneš Michal Beneš (Gar.) **Nonlinear Optimization** 01NELO ΖK 4 3P+0C Radek Fu ik Radek Fu ik Radek Fu ik (Gar.) Advanced Methods of Numerical Linear Algebra 01PNL ΖK 2 2P+0C Ji í Mikyška Ji í Mikyška Ji í Mikyška (Gar.) **Graph Theory** 01TG 5 4P+0C ΖK Jan Volec, Petr Ambrož Petr Ambrož Petr Ambrož (Gar.) 01TINF ΖK 3 2P+0C Information Theory Theory of Random Processes 01NAH ΖK 3 3+0 Ζ Jan Vybíral **Jan Vybíral** Jan Vybíral (Gar.) Variational Methods 01VAM Ζ 7K 3 1P+1C Michal Beneš Michal Beneš Michal Beneš (Gar.) **Research Project 1** Ζ 01VUMM1 Ζ 6 0+6estmír Burdík estmír Burdík estmír Burdík (Gar.) **Research Project 2** 01VUMM2 ΚZ L 8 0+8

Role

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Characteristics of the courses of this group of Study Plan: Code=NMSPMI1 Name=MDP P_MIN 1st year

estmír Burdík (Gar.)

estmír Burdík estmír Burdík

01FAN3	Functional Analysis 3	Z,ZK	5		
Advanced parts of funct	ional analysis needed for theory of representations of Lie groups and quantum theory. Compact operators, their ideals, unbou	inded selfadjoint o	operators, theory		
of selfadjoint extension	of symmetric operators, Stones theorem, quadratic forms and Bochner integral. The basics of Banach algebras and C*-alget	oras.			
01MMDY	Mathematical Methods in Fluid Dynamics 1	ZK	2		
First, the differential equ	First, the differential equations representing the conservation laws of fluid flow are briefly derived and reviewed. Next, the problems for the resulting equations are formulated, focusing				
on boundary conditions	specification. The reference problem undergoes numerical analysis with emphasis on explaining the weak solution and its ro	ole in describing re	eal phenomena.		
In the second part, imp	prtant problems are introduced, involving fluid flow and other effects (heat transfer, chemical reactions, multiphase nature) ar	nd an adequate m	athematical		
description is chosen.					
01MKP	Finite Element Method	ZK	3		
The course is devoted to the mathematical theory of the finite element method numerically solving boundary-value and initial-boundary-value problems for partial differential equations.					
Mathematical properties	s of the method are explained. The approximation error estimates are derived				

01NELO	Nonlinear Optimization	ZK	4		
	problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programmin				
	nethods for unconstrained and constrained optimization. The lecture is supplemented by illustrative examples.	ig theory with enit			
01PNL		ZK	2		
-	Advanced Methods of Numerical Linear Algebra		-		
	numbers in computers, behaviour of rounding errors during numerical computations, sensitivity of a problem, numerical stability of a problem of the sensitivity of a problem of the sensitivity of a problem.				
, ,	alues of a given matrix and sensitivity of roots of systems of linear algebraic equations. Then, the backward analysis of these		•		
	se is devoted to the methods of QR-decomposition, least squares problem, and to several modern Krylov subspace methods f	or the solution of s	systems of linear		
	the Lanczos method for approximation of the eigenvalues of a symmetric square matrix.		_		
01TG	Graph Theory	ZK	5		
	theory. 2. Edge and vertex connectivity (Menger Theorem). 3. Bipartite graphs. 4. Trees and forests. 5. Spanning trees (Matri	,			
and Hamilton cycles. 7.	Maximal and perfect matching. 8. Edge coloring. 9. Flows in networks. 10. Vertex coloring. 11. Plannar graphs (Kuratowski the	eorem), vertex co	loring of planar		
graphs. 12. Spectrum of	the adjacency matrix. 13. Extremal graph theory.				
01TINF	Information Theory	ZK	3		
Information theory explo	ores the fundamental limits of the representation and transmission of information. We will focus on the definition and implicati	ons of (informatio	n) entropy, the		
source coding theorem,	and the channel coding theorem. These concepts provide a vital background for researchers in the areas of data compressi	on, signal proces	sing, controls,		
and pattern recognition.					
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 se	quences both we	akly and strongly		
stationary ones.					
01VAM	Variational Methods	ZK	3		
The course is devoted to	the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity of	r monotonicity. Fu	urther, it contains		
investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.					
01VUMM1	Research Project 1	Z	6		
Research project on the selected topic under the supervision. Supervision and regular checking of the research project under preparation.					
01VUMM2	Research Project 2	KZ	8		
Research project on the	selected topic under the supervision. Supervision and regular checking of the research project under preparation.	-	•		

Code of the group: NMSPMI2

Name of the group: NMS P_MIN 2nd year

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 7 courses Credits in the group: 0

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
01AOM	Applications of Optimization Methods Tomáš Oberhuber Tomáš Oberhuber (Gar.)	ZK	2	1P+1C		Р
01ASY	Asymptotical Methods Ji í Mikyška Ji í Mikyška Ji í Mikyška (Gar.)	Z,ZK	3	2+1	Z	Р
01DPMM1	Master Thesis 1 estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	10	0+10	Z	Р
01DPMM2	Master Thesis 2 estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	20	0+20	L	Р
01MMNS	Mathematical Modelling of Non-linear Systems Michal Beneš Michal Beneš Michal Beneš (Gar.)	ZK	3	1P+1C	Z	Р
01MRMMI	Methods for Sparse Matrices Ji í Mikyška Ji í Mikyška Ji í Mikyška (Gar.)	KZ	2	2P+0C		Р
01DISE	Diploma Seminar estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	1	0P+2S		Р

Characteristics of the courses of this group of Study Plan: Code=NMSPMI2 Name=NMS P_MIN 2nd year

01AOM	Applications of Optimization Methods	ZK	2		
Aim of this course is to enhance the knowledge of the optimization methods and show their practical applications. Number of methods are applied on the support-vector machines and					
subsequently, methods	for large problems and training of deep artificial neural networks are explained. Finaly, advanced methods for regret minimiza	ation or sparsity in	ducing methods		
are explained. All metho	ods are demonstrated on real problems.				
01ASY	Asymptotical Methods	Z,ZK	3		
Examples. Addition par	ts of mathematical analysis (generalized Lebesgue integral, parametric integrals.) Asymptotic relations a expansions - proper	ties; algebraical a	and analytical		
operations. Applied asy	mptotics of sequences and sums; integrals of Laplace and Fourier type.				
01DPMM1	Master Thesis 1	Z	10		
Master's thesis prepara	tion.				
01DPMM2	Master Thesis 2	Z	20		
Master's thesis prepara	tion.				
01MMNS	Mathematical Modelling of Non-linear Systems	ZK	3		
The course consists of	basic terms and results of the theory of finite- and infinitedimensional dynamical systems generated by evolutionary differenti	al equations, and	description of		
bifurcations and chaos.	Second part is devoted to the explanation of basic results of the fractal geometry dealing with attractors of such dynamical st	ystems.			
01MRMMI	Methods for Sparse Matrices	KZ	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					

	Diploma Seminar				Z	1
•	ninar, students familiarize themselves with the general principles of publishing and pres	•				
•	I part is designed as a practical training for the defence of the diploma project. The stud on their projects. Each presentation is followed by a discussion on scientific matters a					
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lame of the blo	ock: Compulsory elective courses					
	r of credits of the block: 8					
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ada of the arc	pup: NMSPMIPV1					
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•	oup: NMS P_MIN Required optional courses 1st ye					
•	edits in the group: In this group you have to gain a	it least 8 cre	dits			
•	ourses in the group:					
Credits in the g	•					
Note on the gro	oup: Studenti si povinně zapisuj	jí předměty ale	espoň za	8 kredit	ü.	
	Name of the course / Name of the group of courses					
Code	(in case of groups of courses the list of codes of their members)	Completion	Credits	Scope	Semester	Role
	Tutors, authors and guarantors (gar.)					
01PDE	Modern theory of partial differential equations	Z,ZK	4	2P+1C		PV
	Mat j Tušek Mat j Tuše k Mat j Tušek (Gar.)					
01LBM	Lattice Boltzmann Method Radek Fu ík Radek Fu ík Radek Fu ík (Gar.)	KZ	2	1P+1C		PV
01NMDT	Numerical Methods in Fluid Dynamics	ZK	2	2P+0C		PV
	Pavel Strachota Pavel Strachota Pavel Strachota (Gar.)					
01PAA	Parallel Algorithms and Architectures Tomáš Oberhuber Tomáš Oberhuber (Gar.)	KZ	4	2P+1C	L	PV
01PALG	Advanced Algorithmization	KZ	2	1P+1C		PV
	Tomáš Oberhuber Tomáš Oberhuber Tomáš Oberhuber (Gar.)		-			
01SKE	System Reliability and Clinical Experiments Václav K s Václav K s Václav K s (Gar.)	KZ	3	2+0	L	PV
01SDR	Stochastic Differential Equations	ZK	2	2P+0C		PV
	Michal Beneš Michal Beneš Michal Beneš (Gar.) Matrix Theory					
01TEMA	Edita Pelantová Edita Pelantová Edita Pelantová (Gar.)	Z	3	2+0	L	PV
	the courses of this group of Study Plan: Code=NMSPMIPV1 Na Modern theory of partial differential equations	me=NMS P_MI	N Requir			
1	modern theory of partial differential equations finition, completeness, examples. 3. Continuous and compact embedding theorems. 4.	Trace theorem 5 W	eak solution		Z,ZK	4 f the weak
	DE of Second Order. 7. Existence and uniqueness of weak solutions (Lax-Milgram theo					
variations, Poincaré inequ	uality. 10. Maximum principle for classical and weak solutions.					
1	Lattice Boltzmann Method				KZ	2
	ethod (LBM) is a modern numerical method allowing the solution of non-stationary part the particle probability distribution function. The course introduces the basics of the LB	-	-	-		
	em and for the incompressible Newtonian filluid flow, and the basic properties of the null				•	
	and computations of LBM using the computational infrastructure at FNSPE CTU in Pra					
1	Numerical Methods in Fluid Dynamics				ZK	2
	the design and properties of numerical methods for solving fluid flow equations. Focus i					
	lected schemes are analyzed in terms of stability. The second part is devoted to advan ative numerical approaches for fluid flow simulation and by a demonstration of visualiz			-		
-	Parallel Algorithms and Architectures				KZ	4
	e parallel data processing. It is important in situations when one processing unit (CPU)				in reasonable	time. Whe
This course deals with th	nms, good knowledge of the parallel architectures is important. Therefore these archite	ctures are studied a	s a part of th	his course to		
This course deals with th designing parallel algorith					KZ	2
This course deals with the designing parallel algorithe D1PALG	Advanced Algorithmization	do for colution of no	rtial difforan	tial aquation		
This course deals with the designing parallel algorith D1PALG Keywords: String algorith	Advanced Algorithmization ms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical metho	ods for solution of pa	rtial differen	tial equation		3
This course deals with the designing parallel algorith D1PALG Keywords: String algorith D1SKE	Advanced Algorithmization				KZ	3 otic metho
This course deals with the designing parallel algorith 01PALG Keywords: String algorith 01SKE The main goal of the subj	Advanced Algorithmization ms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical metho System Reliability and Clinical Experiments	val data analysis, reli	iability of cor	mponent sy	KZ stems, asympt	otic metho
This course deals with the designing parallel algorith 01PALG Keywords: String algorith 01SKE The main goal of the subj for reliability, concept of e originating from lifetime n	Advanced Algorithmization ms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical metho System Reliability and Clinical Experiments ect is to provide the mathematical principles of reliability theory and techniques of survi- experiments under censoring and their processing in clinical trials (life-time models). The naterial experiments and clinical trials.	val data analysis, reli	iability of cor	mponent sy	KZ stems, asymptoin practical exa	otic metho amples
This course deals with the designing parallel algorith 01PALG Keywords: String algorith 01SKE The main goal of the subj for reliability, concept of e originating from lifetime in 01SDR	Advanced Algorithmization ms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical metho System Reliability and Clinical Experiments ect is to provide the mathematical principles of reliability theory and techniques of survi- experiments under censoring and their processing in clinical trials (life-time models). The naterial experiments and clinical trials. Stochastic Differential Equations	val data analysis, reli ne techniques are illu	ability of cor strated and	mponent sy tested with	KZ stems, asymptotic stems, as	otic metho amples 2
This course deals with the designing parallel algorith 01PALG Keywords: String algorith 01SKE The main goal of the subj for reliability, concept of e originating from lifetime in 01SDR The class is devoted to a	Advanced Algorithmization ms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical metho System Reliability and Clinical Experiments ect is to provide the mathematical principles of reliability theory and techniques of surviv experiments under censoring and their processing in clinical trials (life-time models). The naterial experiments and clinical trials. Stochastic Differential Equations n introduction to stochastic differential equations and their applications. The content interial	val data analysis, reli ne techniques are illu	ability of cor strated and	mponent sy tested with	KZ stems, asymptotic stems, as	otic metho amples 2
This course deals with the designing parallel algorith 01PALG Keywords: String algorith 01SKE The main goal of the subj for reliability, concept of e originating from lifetime in 01SDR The class is devoted to a differential equations. The	Advanced Algorithmization ms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical metho System Reliability and Clinical Experiments ect is to provide the mathematical principles of reliability theory and techniques of survi- experiments under censoring and their processing in clinical trials (life-time models). The naterial experiments and clinical trials. Stochastic Differential Equations	val data analysis, reli ne techniques are illu	ability of cor strated and	mponent sy tested with	KZ stems, asymptotic stems, as	otic metho amples 2

Name of the block: Elective courses Minimal number of credits of the block: 0 The role of the block: V Code of the group: NMSPMIV Name of the group: MDP P MIN Optional courses Requirement credits in the group:

Requirement courses in the group:

Credits in the group: 0

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
12DRP	Differential Equations on Computer Richard Liska Richard Liska Richard Liska (Gar.)	Z,ZK	5	2+2	Z	V
01DIZO	Digital Image Processing Barbara Zitová Barbara Zitová Barbara Zitová (Gar.)	ZK	4	2P+2C		V
01FIMA	Financial and Insurance Mathematics Joel Horowitz Joel Horowitz (Gar.)	ZK	2	2P+0C	Z	V
01SPEC	Geometrical Aspects of Spectral Theory David Krej i ík David Krej i ík David Krej i ík (Gar.)	ZK	2	2+0	L	V
18HA	Heuristic Algorithms Jaromír Kukal Jaromír Kukal (Gar.)	ZK	4	2P+2C	L	V
01KOS	Compressed Sensing Jan Vybíral Jan Vybíral Jan Vybíral (Gar.)	ZK	2	2+0	Z	V
02QIC	Quantum Information and Communication Aurél Gábor Gábris Aurél Gábor Gábris Martin Štefa ák (Gar.)	Z,ZK	4	3P+1C	Z	V
04MGA1	English for Academic Purposes Speaking Practice - intermediate Darren Copeland Darren Copeland (Gar.)	Z	2	0+2	L,Z	V
04MGA2	Academic English Writing and Presentation Course - intermadiate Darren Copeland (Gar.)	Z	2	0+2	L,Z	V
01MAL	Mathematical Logic Petr Cintula Petr Cintula Petr Cintula (Gar.)	Z,ZK	4	2+1		V
01MBM	Mathematical techniques in biology and medicine Václav Klika Václav Klika Václav Klika (Gar.)	Z,ZK	3	2+1	L	V
18MEMC	Monte Carlo Method Jaromír Kukal, Miroslav Virius Miroslav Virius (Gar.)	Z,ZK	4	2P+2C	Z	V
01SMF	Modern Trends in Corporate Information Technologies Tomáš Oberhuber Tomáš Oberhuber Tomáš Oberhuber (Gar.)	Z	2	2	L	V
1800P	Object Oriented Programming Miroslav Virius Miroslav Virius Miroslav Virius (Gar.)	Z	2	2C	Z	V
18PCP	Advanced C++ Miroslav Virius Miroslav Virius (Gar.)	Z,ZK	4	2P+2C	L	V
01PAMF	Mainframe Programming in Assembler Tomáš Oberhuber Tomáš Oberhuber (Gar.)	Z	2	2	L	V
01DPR	Pre-diploma Practice Michal Beneš Michal Beneš (Gar.)	Z	4	2XT		V
01SUP	Start-up Project P emysl Rubeš P emysl Rubeš (Gar.)	KZ	2	2P+0C		V
01SVK	Student's Scientific Conference Kate ina Horaisová Ji í Mikyška Ji í Mikyška (Gar.)	Z	1	5 dní		V
01TEC	Number Theory Edita Pelantová, Zuzana Masáková Zuzana Masáková Zuzana Masáková (Gar.)	ZK	5	4P+0C		V
01UMF	Introduction to Mainframe Tomáš Oberhuber Tomáš Oberhuber (Gar.)	Z	2	1P+1C	Z	V
01URG	Introduction to Riemannian geometry David Krej i ík David Krej i ík David Krej i ík (Gar.)	ZK	2	2+0	Z	V
01UTS	Introduction to the Theory of Semigroups Václav Klika Václav Klika Václav Klika (Gar.)	ZK	3	2P+0C		V
02VPSFA	Selected Topics in Statistical Physics and Thermodynamics Igor Jex Martin Štefa ák Igor Jex (Gar.)	Z,ZK	7	4P+2C	Z	V

Characteristics of the courses of this group of Study Plan: Code=NMSPMIV Name=MDP P_MIN Optional courses

12DRP Differential Equations on Computer Z,ZK 5 Ordinary differential equations, analytical methods; Ordinary differential equations, numerical methods, Runge-Kutta methods, stability; Partial differential equations, analysis, hyperbolik, parabolic and elliptic equations, posedness of differential equaitons; Partial differential equations, numerical solution, finite difference methods, difference schemes, order of approximation, stability, convergence, modified equation, diffusion, dispersion; Conservation laws and their numerical solution, shallow water equations, Euler equations, Lagrangian methods, ALE methods; Practical computation in Matlab system for numerics and Maple for analysis of schemes. ΖK 4

01DIZO **Digital Image Processing**

image sampling and quantization, Shannon theorem, aliasing basic image operations, histogram, contrast stretching, noise removal, image sharpening linear filtering in the spatial and frequency domains, convolution, Fourier transform edge detection, corner detection feature detection image degradations and their modelling, inverse and Wiener filtering, restoration of motion-blurred and out-of-focus blurred images image segmentation mathematical morphology image registration and matching

01FIMA Financial and Insurance Mathematics	ZK	2
This course is an introduction to the problems of life and non-life insurance and financial mathematics.	210	-
01SPEC Geometrical Aspects of Spectral Theory	ZK	2
1. Motivations. The crisis of classical physics and the rise of quantum mechanics. Mathematical formulation of quantum theory. Spectral problems in	classical physics.	2. Elements of
functional analysis. The discrete and essential spectra. Sobolev spaces. Quadratic forms. Schrödinger operators. 3. Stability of the essential spectrum	-	
Variational and perturbation methods. 4. The role of the dimension of the Euclidean space. Criticality versus subcriticality. The Hardy inequality. Stabi aspects. Glazman's classification of Euclidean domains and their basic spectral properties. 6. Vibrational systems. The symmetric rearrangement an	-	
the principal frequency. 7. Quantum waveguides. Elements of differential geometry: curves, surfaces, manifolds. Effective dynamics. 8. Geometrically		
Hardy-type inequalities in tubes.		
18HA Heuristic Algorithms	ZK	4
Heuristic algorithms of optimization operates on discrete or continuous domains. Brutal force, stochastic, greedy, physically, biologically and sociolog	ically motivated h	euristic are
included, used for optimum finding and compared.		
01KOS Compressed Sensing	ZK	2
The lecture will introduce basic concepts of the theory of compressed sensing an area founded in 2006 in the works of D. Donoho, E. Candes, and T search for sparse solutions of underdetermined systems of linear equations. Due to the applications of sparse representations in electric engeneering	-	
was quickly used in many different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NI	• •	. ,
sparse solutions of systems of linear equations. We introduce conditions which ensure also existence of more effective solvers and show, that these	•	
Gaussian random matrices. As an effective solution method, we will analyze I1-minimization and Orthogonal Matching Pursuit. We will also study stability of the solution of th	lity and robustnes	s of the obtained
results with respect to the corruption of measurements and the optimality of the results.		
02QIC Quantum Information and Communication	Z,ZK	4
Quantum theory brought new ideas to the theory of information leading which ultimately lead to the theory of quantum information, computation and introduces the basic concepts of quantum information e.g. quantum algorithms (Shors and Grovers), entanglement, quantum teleportation, quantum		
correction. It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation ar		
04MGA1 English for Academic Purposes Speaking Practice - intermediate	Z	2
Optional course offers Master's Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and	speaking skills. C	ourse syllabus
will respond to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded ass	essment course.	
04MGA2 Academic English Writing and Presentation Course - intermadiate	Z	2
Optional course, a possible free sequel to course 04MGA1, offers Master's degree students at intermediate level of English a chance to develop, im	-	-
and presentation skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation instruction on writing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course will be a set of the set		•
course.	se is a non-grade	u assessment
01MAL Mathematical Logic	Z,ZK	4
Logic is in the same time an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to	,	otion of results
of classical mathematical logic. 1. Propositions, evaluation, tautologies, axioms, theorems, soundness, completeness, and decidability of Hilbert and C	Gentzen style prop	ositional calculi.
2. Language of predicate calculus, terms, formulas, relational structures, satisfiability, truth, tautologies, axioms, theorems, soundness, model constructures, satisfiability, truth, tautologies, axioms, theorems, soundness, tautologies, axioms, tautologies, axioms, theorems, soundness, model constructures, satisfiability, truth, tautologies, axioms, theorems, soundness, tautologies, axioms, t		
theorem, Skolem and Herbrand theorems. 4.The first and the second Gödel theorems on incompleteness of Peano arithmetics and undecidability of 01MBM Mathematical techniques in biology and medicine	Z,ZK	s. 3
01MBM Mathematical techniques in biology and medicine Spatially independent models; enzyme kinetics; excitable system; reaction-diffusion equations; travelling waves; pattern formation; conditions for Turi	,	-
size; the concept of stability in PDEs, spectrum of a linear operator, semigroups.		
18MEMC Monte Carlo Method	Z,ZK	4
This course is devoted to the numerical method Monte Carlo and to its selected applications.		
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 non-relational databases in the mainframe environment.	on systems, virtua	lization and
1800P Object Oriented Programming	Z	2
This course consists of the contributions of students concerning given topics concerned on technologies uded in program development.	2	2
18PCP Advanced C++	Z,ZK	4
This lecture covers the virtual inheritance, variadic templetes, template metaprogramming, template libraries design and implementation, tools for da		g in compile time
and for the advanced diagnostic of the templates, concepts, coroutines, modules, ranges, views and other tools introduced in C++ 20, application of	the multithreading	g (execution
	7	
01PAMF Mainframe Programming in Assembler	Z	2 and some other
In this course the basics of programming in z/OS are explained namely the programming in assembler. Basic instructions, macros, I/O operations, D topics are discussed.	LL library loading	and some other
01DPR Pre-diploma Practice	Z	4
The practice serves for broadening knowledge related to the contents of the Masters Thesis, for close interaction with the supervisor and focused two-	_	•
The course should support the emergence of results that will become part of the masters degree project. The practice is usually carried out at the su	ipervisor's workpl	ace.
01SUP Start-up Project	KZ	2
01SVK Student's Scientific Conference	Z	1
This is the active participation of the student in one of the approved student conferences. The list of such conferences is defined by the course guara		_
01TEC Number Theory	ZK a aquational Dallu	5
1. Algebraic and transcendental numbers 2. Algebraic number fields, field isomorphisms 3. Rational approximations, continued fractions 4. Diophanti Rings of integers in algebraic number fields and divisibility 6. Number representation in non-integer bases, finite and periodic expansions	c equations, Pell's	s equation 5.
01UMF Introduction to Mainframe	7	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 sor	_	_
in C/C++ for z/OS:		
01URG Introduction to Riemannian geometry	ZK	2
This lecture is intended for an advanced undergraduate having possibly (but not necessarily) already taken a basic course on topological and different		
understanding the geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometric meaning of the student will be s		-
of modern parts of mathematics and mathematical physics. Possible extension of this lecture is the geometric analysis of partial differential equation	s on kiemannian	manifolds.

01UTS	Introduction to the Theory of Semigroups	ZK	3		
It is known that a system of linear ordinary differential equations can be solved by virtue of the matrix exponential. However, the extension to partial differential equations is not					
straightforward. For exa	mple in the case of heat equation the matrix is replaced by Laplace operator which is not bounded and the series for the expor	nential will not con	verge. Moreover,		
solutions of the heat eq	uation exist in general only for positive times and hence the solution operator can be at best a semigroup. The aim of the cou	irse is to provide a	a mathematical		
foundation for these typ	es of problems and extend the concept of stability from ordinary differential equations, which is again in relation to spectrum	of a linear operat	or.		
02VPSFA	Selected Topics in Statistical Physics and Thermodynamics	Z,ZK	7		
The course concentrates on some advanced topics of statistical mechanics not discussed in the basic course on thermodynamics and statistical physics. Question concerning density					
matrices, the behaviour	s of nonideal gases and its macroscopic description, microscopic description of phase transitions, the role of fluctuations are	addressed in det	ail.		

List of courses of this pass:

results with respect to the corruption of measurements and the optimality of the results. KZ 2 O1LBM Lattice Boltzmann Method KZ 2 The lattice Boltzmann method (LBM) is a modern numerical method allowing the solution of non-stationary partial differential equations by solving the Boltzmann transport equation for unknown densities of the particle probability distribution function. The course introduces the basics of the LBM theory, derived equivalent partial differential equations for an advection-diffusion problem and for the incompressible Newtonian flluid flow, and the basic properties of the numerical scheme are derived. The exercises are then devoted to the practical implementation and computations of LBM using the computational infrastructure at FNSPE CTU in Prague, especially with the focus on GPU computing. 01MAL Mathematical Logic Z,ZK 4 Logic is in the same time an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to introduce basic notion of results of classical mathematical logic. 1. Propositions, evaluation, tautologies, axioms, theorems, soundness, model constructions. 3. Gödel completeness theorem, Skolem and Herbrand theorems. 4. The first and the second Gödel theorems on incompleteness of Peano arithmetics and undecidability of predicate calculus. 01MBM Mathematical techniques in biology and medicine Z,ZK 3 01MBM Mathematical techniques in biology and medicine size; the concet of stability in PDEs, spectrum of a linear operator, semigroups. 01MBM Z/K 3	Code	Name of the course	Completion	Credits
subsequents, methods for large problems and training of deep artificial noval networks are septimed. Training subanced methods can be demonstrated on real process. 01ASY Asymptotical Methods are demonstrated on real process. ZZK 3 01DEX Diploma Seminar Z 1 11 in the first of the seminar, students familiarize Latesgue integrale. J Asymptotic relations a separations - properties: algebraical and analytical and processor of the doptom projects. 1 1 11 in the first of the seminar, students familiarize themselves with the general principies of publishing and presenting solutilities of improving the students performance. 1 1 01DIDE Diplotal mage Processing Z 1 11 range and quantification. Stamon theorem, aliasing basic image operations, histogram, contrast stretching, noise removel, image and Viewer filtering in the spatial and quantification. Stamon theorem, aliasing basic images image segmentation mathematical morphology image registration and methods in demonstration. Z 10 01DPMM1 Master's thesis preparation. Z 20 01DPMM2 Master's thesis preparation. Z 20 01DPMM1 Master's thesis preparation. Z 20 01DPMM2 Master's thesis preparation. Z 20 01DPMM2 Proceipforme Practice Z 4 11DR	01AOM	Applications of Optimization Methods	ZK	2
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101ASY Asymptotical Methods ZZK 3 Examples. Addition parts of mathematical analysis of expansions. Properties: algobraical and analysical parametric integrals.) Asymptote rolations a expansions. Properties: algobraical and analysical transmitter integrals. Displayments of inclusions a expansions. Properties: algobraical and analysical integrations. Addition paratices and sums; integrate of Laplace and Fourier type. 1 101DEX Diploma Sermian Z 1 In the first part of the sermina: students familiarize thermachives with the general principles of publishing and presenting confirm constrat state of the servents attae of the resent- neutilis as the second part is designed as a prancial raining to the disfarce of the diploma project. The students give and the immediation integrate designed with the spatial and the immediating in the spatial and out-of-focus blurred image segneration. Instate strength, mode designed and the immediation and matching 10 01DPMM1 Master's thesis preparation. Z 10 10 01DPMM2 Master's thesis preparation. Z 10 10 01DPMM2 Master's thesis preparation. Z 4 01DPMM1 Master's thesis preparation. Z 4 01DPMM2 Master's thesis preparation. Z 4 01DPMM2 Master's thesis preparation. Z 4 <td>subsequently, meth</td> <td></td> <td>n or sparsity induci</td> <td>ng methods</td>	subsequently, meth		n or sparsity induci	ng methods
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The lecture will introduce basic concepts of the theory of compressed sensing an area founded in 2006 in the works of D. Donoho, E. Candes, and T. Tao. This theory studies the search for sparse solutions of underdetermined systems of linear equations. Due to the applications of sparse representations in electric engeneering and signal processing, this theory was quickly used in many different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NP-completeneess of the search for sparse solutions of systems of linear equations. We introduce conditions which ensure also existence of more effective solvers and show, that these are satisfied for example for Gaussian random matrices. As an effective solvers on method, we will analyze 11-minimization and Orthogonal Matching Pursuit. We will also study stability and robustness of the obtained results with respect to the corruption of measurements and the optimality of the results. 01LBM Lattice Boltzmann Method KZ 2 01LBM Lattice Boltzmann for the corruption of measurements and the optimality of the results. KZ 2 01LBM Lattice Boltzmann Method KZ 2 01LBM Lattice Boltzmann for unknown densities of the particle probability distribution function. The course introduces the basic of the LBM theory, derived equivalent partial differential equations for an advection-diffusion problem and for the incompressible Newtonian filtuid flow, and the basic properties of the numerical scheme are derived. The exercises are then devoted to the particle implementation and computations of LBM using the computational infrastructure at NSPE CTU in Prague, especially with the focus on GPU computing. 01MAL <td< td=""><td>041/00</td><td></td><td>71/</td><td>0</td></td<>	041/00		71/	0
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01MMNS	Mathematical Modelling of Non-linear Systems	ZK	3
The course consi	sts of basic terms and results of the theory of finite- and infinitedimensional dynamical systems generated by evolutionary differential	equations, and de	scription of
	ations and chaos. Second part is devoted to the explanation of basic results of the fractal geometry dealing with attractors of such dy	,	1
_01MRMMI	Methods for Sparse Matrices	KZ	2
	ned at utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will cover	-	-
symmetric and p	positive definite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods a issues will be covered.	ina common imple	mentation
01NAH	Theory of Random Processes	ZK	3
	ted in part to the basic notions of the general theory of random processes and partially to the theory of stationary processes and seque		-
	stationary ones.	,	0,7
01NELO	Nonlinear Optimization	ZK	4
Nonlinear optimiza	tion problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programming the	, ,	is on convex
	optimization and basic methods for unconstrained and constrained optimization. The lecture is supplemented by illustrative examples and the second se	-	
01NMDT	Numerical Methods in Fluid Dynamics	ZK	2
	sed on the design and properties of numerical methods for solving fluid flow equations. Focus is put mainly on the finite volume method ved. Selected schemes are analyzed in terms of stability. The second part is devoted to advanced numerical schemes used in practic		
	brief summary of alternative numerical approaches for fluid flow simulation and by a demonstration of visualization techniques for sim		nciudeu by
01PAA	Parallel Algorithms and Architectures	KZ	4
	with the parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish given t		-
desigr	ning parallel algorithms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part	of this course too.	
01PALG	Advanced Algorithmization	KZ	2
Keywo	ords: String algorithms, graph algorithms, dynamic programming, suffix tress, graph cuts, numerical methods for solution of partial diffe	erential equations.	
01PAMF	Mainframe Programming in Assembler	Z	2
In this course the	pasics of programming in z/OS are explained namely the programming in assembler. Basic instructions, macros, I/O operations, DLL	ibrary loading and	some other
	topics are discussed.		
01PDE	Modern theory of partial differential equations	Z,ZK	4
	s. 2. Definition, completeness, examples. 3. Continuous and compact embedding theorems. 4. Trace theorem. 5. Weak solution (import Elliptic PDE of Second Order. 7. Existence and uniqueness of weak solutions (Lax-Milgram theorem). 8. Regularity of weak solutions.		
	variations, Poincaré inequality. 10. Maximum principle for classical and weak solutions.		
01PNL	Advanced Methods of Numerical Linear Algebra	ZK	2
	real numbers in computers, behaviour of rounding errors during numerical computations, sensitivity of a problem, numerical stability o		1
sensitivity of the e	igenvalues of a given matrix and sensitivity of roots of systems of linear algebraic equations. Then, the backward analysis of these pr	oblems will be perf	ormed. 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	ne solution of syste	ems of linear
	algebraic equations and the Lanczos method for approximation of the eigenvalues of a symmetric square matrix.	714	
01SDR	Stochastic Differential Equations roted to an introduction to stochastic differential equations and their applications. The content includes stochastic processes, Itô integr	ZK	2
	differential equations. The applications in filtering, diffusion and optimal control are mentioned as well.		SIUCHASIIC
01SKE	System Reliability and Clinical Experiments	KZ	3
	he subject is to provide the mathematical principles of reliability theory and techniques of survival data analysis, reliability of component		otic methods
for reliability, co	ncept of experiments under censoring and their processing in clinical trials (life-time models). The techniques are illustrated and teste	d within practical e	examples
	originating from lifetime material experiments and clinical trials.		1
_01SMF	Modern Trends in Corporate Information Technologies	Z	2
The course is de	evoted to mainframe administration basics. After introduction to mainframe hardware the following lectures covers security, transactior non-relational databases in the mainframe environment.	n systems, virtualiz	ation and
01SPEC	Geometrical Aspects of Spectral Theory	ZK	2
	e crisis of classical physics and the rise of quantum mechanics. Mathematical formulation of quantum theory. Spectral problems in cla		
	s. The discrete and essential spectra. Sobolev spaces. Quadratic forms. Schrödinger operators. 3. Stability of the essential spectrum.		
-	perturbation methods. 4. The role of the dimension of the Euclidean space. Criticality versus subcriticality. The Hardy inequality. Stabil	-	
aspects. Glazma	n's classification of Euclidean domains and their basic spectral properties. 6. Vibrational systems. The symmetric rearrangement and t	he Faber-Krahn in	equality for
the principal fro	equency. 7. Quantum waveguides. Elements of differential geometry: curves, surfaces, manifolds. Effective dynamics. 8. Geometrically	induced bound sta	ates and
	Hardy-type inequalities in tubes.		
01SUP	Start-up Project	KZ	2
01SVK	Student's Scientific Conference	Z	1
01TEC	s is the active participation of the student in one of the approved student conferences. The list of such conferences is defined by the conferences.		F
	INUMDER THEORY transcendental numbers 2. Algebraic number fields, field isomorphisms 3. Rational approximations, continued fractions 4. Diophantic	ZK equations Pell's e	5 5
	Rings of integers in algebraic number fields and divisibility 6. Number representation in non-integer bases, finite and periodic exp		quation 0.
01TEMA	Matrix Theory	Z	3
	s mainly with: 1) similarity of matrices and canonical forms of matrices 2) Perron-Frobenius theory and its applications 3) tensor prod		
	semidefinite matrices		
01TG	Graph Theory	ZK	5
	graph theory. 2. Edge and vertex connectivity (Menger Theorem). 3. Bipartite graphs. 4. Trees and forests. 5. Spanning trees (Matrix-		
and Hamilton cyc	les. 7. Maximal and perfect matching. 8. Edge coloring. 9. Flows in networks. 10. Vertex coloring. 11. Plannar graphs (Kuratowski theor	em), vertex colorir	ng of planar
	graphs. 12. Spectrum of the adjacency matrix. 13. Extremal graph theory.	71/	2
01TINF	Information Theory y explores the fundamental limits of the representation and transmission of information. We will focus on the definition and implication	ZK s of (information) e	3
	eorem, and the channel coding theorem. These concepts provide a vital background for researchers in the areas of data compression		
	and pattern recognition.		,
01UMF	Introduction to Mainframe	Z	2
In this course we t	each the mainframe architecture. We explain how to operate the system z/OS, how to start a job using the JCL and we explain some of	lifferences when p	rogramming
	in C/C++ for z/OS:		

01URG	Introduction to Riemannian geometry	ZK	2		
This lecture is in	tended for an advanced undergraduate having possibly (but not necessarily) already taken a basic course on topological and differer	tial manifolds. In a	ddition to		
understanding the geometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geometry suitable for further study					
of modern parts	of mathematics and mathematical physics. Possible extension of this lecture is the geometric analysis of partial differential equations	s on Riemannian m	anifolds.		
01UTS	Introduction to the Theory of Semigroups	ZK	3		
It is known that	a system of linear ordinary differential equations can be solved by virtue of the matrix exponential. However, the extension to partial	differential equation	ns is not		
straightforward. For	r example in the case of heat equation the matrix is replaced by Laplace operator which is not bounded and the series for the exponent	ial will not converge	e. Moreover,		
solutions of the he	eat equation exist in general only for positive times and hence the solution operator can be at best a semigroup. The aim of the course	is to provide a ma	thematical		
foundation f	or these types of problems and extend the concept of stability from ordinary differential equations, which is again in relation to spectr	um of a linear oper	ator.		
01VAM	Variational Methods	ZK	3		
The course is devo	ted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or m	onotonicity. Further	r, it contains		
	investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.				
01VUMM1	Research Project 1	Z	6		
	Research project on the selected topic under the supervision. Supervision and regular checking of the research project under prej	paration.			
01VUMM2	Research Project 2	KZ	8		
	Research project on the selected topic under the supervision. Supervision and regular checking of the research project under prej	paration.			
02QIC	Quantum Information and Communication	Z,ZK	4		
Quantum theory	brought new ideas to the theory of information leading which ultimately lead to the theory of quantum information, computation and	communication. Th	e lecture		
introduces the bas	ic concepts of quantum information e.g. quantum algorithms (Shors and Grovers), entanglement, quantum teleportation, quantum cr	ptography and qua	antum error		
correction.	It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation	n and quantum wa	ılks.		
02VPSFA	Selected Topics in Statistical Physics and Thermodynamics	Z,ZK	7		
	trates on some advanced topics of statistical mechanics not discussed in the basic course on thermodynamics and statistical physics				
matrices, the	behaviours of nonideal gases and its macroscopic description, microscopic description of phase transitions, the role of fluctuations	are addressed in d	etail.		
04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2		
	ffers Master's Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and sp	-	-		
	d to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-grade	d assessment cour			
04MGA2	Academic English Writing and Presentation Course - intermadiate	Z	2		
	possible free sequel to course 04MGA1, offers Master's degree students at intermediate level of English a chance to develop, improv		•		
	kills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on				
instruction on writ	ing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course	is a non-graded as	ssessment		
40000	course.	774			
12DRP	Differential Equations on Computer	Z,ZK	5		
	I equations, analytical methods; Ordinary differential equations, numerical methods, Runge-Kutta methods, stability; Partial differential equations, numerical particle and the stability; Partial differential equations, numerical methods, Runge-Kutta methods, stability; Partial differential equations, numerical particle and the stability; Partial differential equations, numerical equations, numerica				
	c equations, posedness of differential equaitons; Partial differential equations, numerical solution, finite difference methods, difference sc nce, modified equation, diffusion, dispersion; Conservation laws and their numerical solution, shallow water equations, Euler equation				
stability, converge	methods; Practical computation in Matlab system for numerics and Maple for analysis of schemes.	is, Lagrangian met	nous, ALE		
18HA	Heuristic Algorithms	ZK	4		
	ms of optimization operates on discrete or continuous domains. Brutal force, stochastic, greedy, physically, biologically and sociologi	_··			
	included, used for optimum finding and compared.	sally motivated nee			
18MEMC	Monte Carlo Method	Z,ZK	4		
	This course is devoted to the numerical method Monte Carlo and to its selected applications.	2,213			
1800P	Object Oriented Programming	Z	2		
IUUUF	This course consists of the contributions of students concerning given topics concerned on technologies uded in program develo	I I	2		
	Advanced C++	Z.ZK	4		
	the virtual inheritance, variadic templetes, template metaprogramming, template libraries design and implementation, tools for data ty	I ' I			
	nced diagnostic of the templates, concepts, coroutines, modules, ranges, views and other tools introduced in C++ 20, application of the templates of templates of the templates of templa		· ·		
	parallelization).	ie manual occurry (
L	paranonization).				

For updated information see <u>http://bilakniha.cvut.cz/en/FF.html</u> Generated: day 2025-08-10, time 14:02.