Study plan

Name of study plan: Aplikovaná algebra a analýza

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Applied Algebra and Analysis

Type of study: Follow-up master full-time

Required credits: 0

Elective courses credits: 120 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: NMSPAAA1

Name of the group: MDP P_AAAN 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.

Note on the grou	μ.					
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
01FAN3	Functional Analysis 3 Pavel Š oví ek Pavel Š oví ek (Gar.)	Z,ZK	5	2P+2C	Z	Р
01PDE	Modern theory of partial differential equations Mat j Tušek Mat j Tušek (Gar.)	Z,ZK	4	2P+1C		Р
01NELO	Nonlinear Optimization Radek Fu ik Radek Fu ik Radek Fu ik (Gar.)	ZK	4	3P+0C		Р
01TG	Graph Theory Jan Volec, Petr Ambrož Petr Ambrož (Gar.)	ZK	5	4P+0C		Р
01NAH	Theory of Random Processes Jan Vybíral Jan Vybíral (Gar.)	ZK	3	3+0	Z	Р
01TR1	Theory of representations 1 estmír Burdík estmír Burdík estmír Burdík (Gar.)	ZK	2	2+0		Р
01TRE2	Representation theory 2 Severin Pošta Severin Pošta (Gar.)	ZK	5	4P+0C		Р
01URG	Introduction to Riemannian geometry David Krej i ik David Krej i ik David Krej i ik (Gar.)	ZK	2	2+0	Z	Р
01VAM	Variational Methods Michal Beneš Michal Beneš (Gar.)	ZK	3	1P+1C	Z	Р
01VUAA1	Research Project 1 estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	6	0P+6C		Р
01VUAA2	Research Project 2 estmír Burdík estmír Burdík (Gar.)	KZ	8	0P+8C		Р

Characteristics of the courses of this group of Study Plan: Code=NMSPAAA1 Name=MDP P_AAAN 1st year

01FAN3	Functional Analysis 3	Z,ZK	5			
Advanced parts of fund	tional 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 selfadjoint extension of symmetric operators, Stone's theorem, quadratic forms and Bochner integral. The basics of Banach algebras and C*-algebras.					
04000	BA I d C C I Proc C I C	7 71/				

Modern theory of partial differential equations 1. Sobolev spaces. 2. Definition, completeness, examples. 3. Continuous and compact embedding theorems. 4. Trace theorem. 5. Weak solution (importance, derivation of the weak formulation). 6. Elliptic PDE of Second Order. 7. Existence and uniqueness of weak solutions (Lax-Milgram theorem). 8. Regularity of weak solutions. 9. Relation to the calculus of variations, Poincaré inequality. 10. Maximum principle for classical and weak solutions.

01NELO Nonlinear Optimization

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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.

01TG	Graph Theory	ZK	5
1. Basic notion of graph	theory. 2. Edge and vertex connectivity (Menger Theorem). 3. Bipartite graphs. 4. Trees and forests. 5. Spanning trees (Matrix	-Tree Theorem).	6. Euler tours
and Hamilton cycles. 7.	Maximal and perfect matching. 8. Edge coloring. 9. Flows in networks. 10. Vertex coloring. 11. Plannar graphs (Kuratowski the	orem), vertex col	oring of planar
graphs. 12. Spectrum of	the adjacency matrix. 13. Extremal graph theory.		
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 serious	quences both wea	kly and strongly
stationary ones.			
01TR1	Theory of representations 1	ZK	2
Basic knowledge about	representations of groups, with emphasize given to finite groups.	'	
01TRE2	Representation theory 2	ZK	5
Basics of representation	ons of compact groups, Schur's lemma, orthogonality relations, Casimir operators. 2. Lie groups and algebras, matrix groups	, one parametric	subgroups,
exponential map, group	SU(n) and their representations. 3. Decomposition of representations, Clebsh-Gordan coeficients. 4. Gelfand-Tsetlin bases, \	/erma bases 5. F	Representations
of groups and special fu	nctions. 6. Classification of irreducible representations of semisimple Lie algebras, Cartan subalgebra, roots, weights, lattices	Weyl chambers.	7. Classical and
exceptional simple Lie a	lgebras, Dynkin diagrams. 8. Realizations of Lie algebras, Weyl algebras. 9. Representations of Lie superalgerbas, osp(1,2n)		
01URG	Introduction to Riemannian geometry	ZK	2
This lecture is intended	or an advanced undergraduate having possibly (but not necessarily) already taken a basic course on topological and differen	ntial manifolds. In	addition to
understanding the geom	etric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian g	eometry suitable	for further study
of modern parts of math	ematics and mathematical physics. Possible extension of this lecture is the geometric analysis of partial differential equations	on Riemannian	manifolds.
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 o	r monotonicity. Fu	rther, it contains
investigation of quadration	c functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.		
01VUAA1	Research Project 1	Z	6
The research project is I	pased on a topic approved by the administrators of the programme and by the head of the de-partment. The student is guide	d by the project si	upervisor during
common regular meeting	gs and discussions		
01VUAA2	Research Project 2	KZ	8
0110/11/2	Nesearch Floject 2	114	0
	pased on a topic approved by the administrators of the programme and by the head of the de-partment. The student is guiden		-
	pased on a topic approved by the administrators of the programme and by the head of the de-partment. The student is guide		-

Code of the group: NMSPAAA2

Name of the group: MDP P_AAAN 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:

Note on the (Jioup.					
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
01ASY	Asymptotical Methods Ji í Mikyška Ji í Mikyška Ji í Mikyška (Gar.)	Z,ZK	3	2+1	Z	Р
01DPAA1	Master Thesis 1 estmír Burdík estmír Burdík (Gar.)	Z	10	0P+10C		Р
01DPAA2	Master Thesis 2 estmír Burdík estmír Burdík (Gar.)	Z	20	0P+20C		Р
01KOAL	Commutative Algebra Severin Pošta Severin Pošta (Gar.)	ZK	3	1P+1C		Р
01DISE	Diploma Seminar estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	1	0P+2S		Р
01TNM	Random Matrix Theory Jan Vybíral Jan Vybíral (Gar.)	ZK	2	2+0	Z	Р
01UTS	Introduction to the Theory of Semigroups	ZK	3	2P+0C		Р

01UTS Introduction to the Theory of Semigroups Václav Klika Václav Klika (Gar.)	ZK	3	2P+0C		Р
Characteristics of the courses of this group of Study Plan: Code=NMSPAAA2 Name:	=MDP P_AA	AN 2nd y	/ear		
01ASY Asymptotical Methods			Z	,ZK	3
Examples. Addition parts of mathematical analysis (generalized Lebesgue integral, parametric integrals.) Asymptot	ic relations a exp	ansions - p	roperties; alç	ebraical and	l analytical
operations. Applied asymptotics of sequences and sums; integrals of Laplace and Fourier type.					
01DPAA1 Master Thesis 1	•			Z	10
The diploma project is based on a topic approved by the administrators of the programme, department and by the de	ean. The student i	s guided by	the project	supervisor dı	uring common
regular meetings and discussions.					
01DPAA2 Master Thesis 2				Z	20
The diploma project is based on a topic approved by the administrators of the programme, department and by the de	ean. The student i	s guided by	the project	supervisor du	uring common
regular meetings and discussions.					
01KOAL Commutative Algebra				ZK	3
1. Rings, ideals, homomorphisms, prime and maximal ideals. 2. Rings of polynomials, symmetric polynomials, irred	ucibility. 3. Gröbn	er bases. 4	. Polynomial	s with rationa	al coefficients,
factorization of polynomials. 5. Hilbert's Nullstellensatz, ideals and manifolds, Krull dimension. 6. Fields, extensions	, finite fields. 7. In	troduction t	o Galois the	ory, Galois e	xtensions,
group and correspondence.					
01DISE Diploma Seminar	•			Z	1
In the first part of the seminar, students familiarize themselves with the general principles of publishing and present	ing scientific work	and the fo	rmal require	ments for dip	oloma projects
at the faculty. The second part is designed as a practical training for the defence of the diploma project. The student	s give oral preser	tations of t	ho current c	ata of the ro	

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.

01TNM Random Matrix Theory ZK 2

Theory of random matrices appeared first in 60's in the 20th century in connection with statistical physics and the theory of nucleis of atoms of heavy metals. The main interest of study is the distribution of eigenvalues of symmetric random matrices. In the 21st century the results of theory of random matrices were applied in theoretical computer science and numerics for design of random algorithms.

01UTS Introduction to the Theory of Semigroups

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 example in the case of heat equation the matrix is replaced by Laplace operator which is not bounded and the series for the exponential will not converge. Moreover, solutions of the heat 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 mathematical foundation for these types of problems and extend the concept of stability from ordinary differential equations, which is again in relation to spectrum of a linear operator.

Name of the block: Elective courses Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSPAAAV

Name of the group: MDP P_AAAN Optional courses

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

Credits in the group: 0 Note on the group:

Note on the g						
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
02ALT	Algebraic Topology Jan Vysoký Jan Vysok ý Jan Vysoký (Gar.)	Z,ZK	4	2P+2C	Z	V
01ZASIG	Analysis and Processing of Diagnostic Signals Zden k P evorovský Zden k P evorovský (Gar.)	ZK	3	3+0		V
01ASM	Application of Statistical Methods Tomáš Hobza Tomáš Hobza Tomáš Hobza (Gar.)	KZ	2	2+0		V
02COX	Coxeter Groups Ji í Hrivnák Ji í Hrivnák Ji í Hrivnák (Gar.)	Z	2	2+0		V
18DDS	Database System Decomposition Dana Majerová, Jaromír Kukal Dana Majerová Jaromír Kukal (Gar.)	ZK	4	2P+2C	L	V
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
01DYNR1	Dynamic Decision Making 1 Ta jana Gaj, Miroslav Kárný Ta jana Gaj Ta jana Gaj (Gar.)	Z,ZK	3	2P+1C		V
01FIMA	Financial and Insurance Mathematics Joel Horowitz Joel Horowitz Joel Horowitz (Gar.)	ZK	2	2P+0C	Z	V
01SPEC	Geometrical Aspects of Spectral Theory David Krej i ik David Krej i ik David Krej i ik (Gar.)	ZK	2	2+0	L	V
01KOS	Compressed Sensing Jan Vybíral Jan Vybíral (Gar.)	ZK	2	2+0	Z	V
02KFA	Quantum Physics Michal Jex Michal Jex Igor Jex (Gar.)	Z,ZK	6	4P+2C	L	V
01KVGR1	Quantum Groups 1 estmír Burdík estmír Burdík (Gar.)	Z	2	2+0	Z	V
02KVK1	Quantum Circle 1 Pavel Exner (Gar.)	Z	2	0+2	Z	V
02KVK2	Quantum Circle 2 Pavel Exner (Gar.)	Z	2	0+2	L	V
01MAL	Mathematical Logic Petr Cintula Petr Cintula (Gar.)	Z,ZK	4	2+1		V
01MMDY	Mathematical Methods in Fluid Dynamics 1 Pavel Strachota Pavel Strachota (Gar.)	ZK	2	2P+0C	Z	V
01MBM	Mathematical techniques in biology and medicine Václav Klika Václav Klika Václav Klika (Gar.)	Z,ZK	3	2+1	L	V
01MKP	Finite Element Method Michal Beneš Michal Beneš Michal Beneš (Gar.)	ZK	3	1P+1C	L	V
18MEMC	Monte Carlo Method František Gašpar, Miroslav Virius Miroslav Virius (Gar.)	Z,ZK	4	2P+2C	Z	V
01MRMMI	Methods for Sparse Matrices Ji í Mikyška Ji í Mikyška Ji í Mikyška (Gar.)	KZ	2	2P+0C		V
01NEUR1	Neural Networks and their Applications 1 Martin Hole a, František Hakl František Hakl František Hakl (Gar.)	ZK	2	2+0		V
1800P	Object Oriented Programming Miroslav Virius Miroslav Virius (Gar.)	Z	2	2C	Z	V

01PNL	Advanced Methods of Numerical Linear Algebra Ji í Mikyška Ji í Mikyška Ji í Mikyška (Gar.)	ZK	2	2P+0C		V
01UMIN	Probabilistic Models of Artificial Intelligence Ji ina Vejnarová Ji ina Vejnarová (Gar.)	KZ	2	2+0	Z	V
01PSM1	Problem Seminar in Mathematical Analysis Mat j Tušek Mat j Tušek (Gar.)	Z	2	0P+2S	Z	V
01PSM2	Problem Seminar in Mathematical Analysis 2 Mat j Tušek Mat j Tušek (Gar.)	Z	2	28		V
02RMMF	Solvable Models of Mathematical Physics Ladislav Hlavatý Ladislav Hlavatý (Gar.)	Z	2	2+0	L	٧
01SUP	Start-up Project P emysl Rubeš P emysl Rubeš (Gar.)	KZ	2	2P+0C		V
01SVK	Student's Scientific Conference Ji í Mikyška Ji í Mikyška (Gar.)	Z	1	5 dní		V
01SMS1	Student's seminar in mathematics 1 Václav Klika Václav Klika (Gar.)	Z	2	0P+2C		V
01SMS2	Student's seminar in mathematics 2 Václav Klika Václav Klika (Gar.)	Z	2	0P+2C	L	٧
01TEC	Number Theory Zuzana Masáková, Edita Pelantová Zuzana Masáková Zuzana Masáková (Gar.)	ZK	5	4P+0C		V
01TIN	Information Theory Tomáš Hobza Tomáš Hobza Tomáš Hobza (Gar.)	ZK	2	2+0	Z	V
01TEMA	Matrix Theory Edita Pelantová Edita Pelantová (Gar.)	Z	3	2+0	L	V

02ALT	Algebraic Topology	Z,ZK	4
A study of modern i	mathematical and theoretical physics requires one to acquire an ever increasing knowledge of mathematical apparautus. The mai	n goal of this cour	se is to acquair
tudents with basic	methods used in algebraic topology, namely elements of category theory, homototopies, homological algebra and cohomology. An	important objecti	ve is to enhand
ne mathematical la	nguage by concepts appearing universally across disciplines like differential geometry and abstract algebra. During excercise se	ssions, students v	vill try practica
alculations of intro	duced mathematical structures.		
1ZASIG	Analysis and Processing of Diagnostic Signals	ZK	3
igital signal proces	ssing, signal transformations and filtrations, spectral and time-frequency analysis	'	
1ASM	Application of Statistical Methods	KZ	2
he course focuses	on applications of selected methods of statistical data analysis to concrete problems including their solutions using statistical so	ftware. Namely w	e will deal with
ypotheses tests at	pout parameters of normal distribution, nonparametric methods, contingency tables, linear regression and correlation, analysis of	variance.	
2COX	Coxeter Groups	Z	2
he course is an in	troduction to the theory of Coxeter groups and their invariant theory. The case of the finite Coxeter groups - the reflection groups	and their propertic	s are studied
he notions of the V	Veyl chamber and length are defined. General theory of the Coxeter groups, the corresponding bilinear forms and the theory of the	ir classification re	present abstra
eneralization of the	e reflection groups. The study of affine Weyl groups and related objects forms basic example of infinite Coxeter groups. As an intr	oduction to the in	variant theory
he MacDonald ider	ntity and the Weyl identity are presented.		
8DDS	Database System Decomposition	ZK	4
he lectures are ori	ented to basic terms, database objects, their properties and relationships together with the accent to logics of decomposition and a	plications of data	oase operation
2DRP	Differential Equations on Computer	Z,ZK	5
rdinary differential	equations, analytical methods; Ordinary differential equations, numerical methods, Runge-Kutta methods, stability; Partial different	ial equations, ana	lysis, hyperbo
arabolic and elliptic	equations, posedness of differential equaitons; Partial differential equations, numerical solution, finite difference methods, difference	schemes, order o	of approximation
ability convergen	ce, modified equation, diffusion, dispersion; Conservation laws and their numerical solution, shallow water equations, Euler equat	ions, Lagrangian	methods, ALE
tability, control goin			
	computation in Matlab system for numerics and Maple for analysis of schemes.		
	computation in Matlab system for numerics and Maple for analysis of schemes. Digital Image Processing	ZK	4

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

01DYNR1 Dynamic Decision Making 1

Z,ZK

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, NeurIPS, 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.

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. Weyl's theorem. Bound states. Variational and perturbation methods. 4. The role of the dimension of the Euclidean space. Criticality versus subcriticality. The Hardy inequality. Stability of matter. 5. Geometrical aspects. Glazman's classification of Euclidean domains and their basic spectral properties. 6. Vibrational systems. The symmetric rearrangement and the Faber-Krahn inequality for the principal frequency. 7. Quantum waveguides. Elements of differential geometry: curves, surfaces, manifolds. Effective dynamics. 8. Geometrically induced bound states and Hardy-type inequalities in tubes.

01KOS	Compressed Sensing	ZK	2
	e basic concepts of the theory of compressed sensing – an area founded in 2006 in the works of D. Donoho, E. Candes, and ons of underdetermined systems of linear equations. Due to the applications of sparse representations in electric engeneering		
•	ny different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NF	• .	
	ems of linear equations. We introduce conditions which ensure also existence of more effective solvers and show, that these		
	ces. As an effective solution method, we will analyze I1-minimization and Orthogonal Matching Pursuit. We will also study stabine corruption of measurements and the optimality of the results.	lity and robustness	s of the obtained
02KFA	Quantum Physics	Z,ZK	6
	s formulating and developing quantum theory as a physically motivated, but mathematically rigorous theory built upon the an		-
linear operators on sepa	arable Hilbert spaces. Previous knowledge of quantum mechanics is an advantage but not a predisposition for the course. The	e pivot point is the	e establishing of
·	he theory and deriving their consequences for model systems, as well as a detailed study of the most commonly used observ	•	mechanics. The
01KVGR1	exactness and proofs of the statements. Some common mistakes resulting from breaking the assumptions of these are also c Quantum Groups 1	z Z	2
-	riginated in the 80s in the works of professor L. D. Faddeev and the Leningrad school on the inverse scattering method in or		
-	ations in mathematics and mathematical physics such as the classification of nodes, in the theory of integrable systems and	_	
02KVK1	Quantum Circle 1	Z	2
	r Institute on topics of mathematical quantum physics for students and PhD. students.		
02KVK2	Quantum Circle 2	Z	2
01MAL	r Institute on topics of mathematical quantum physics for students and PhD. students. Mathematical Logic	Z,ZK	4
	e an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to	. , .	-
of classical mathematical	al logic. 1.Propositions, evaluation, tautologies, axioms, theorems, soundness, completeness, and decidability of Hilbert and C	Gentzen style prop	ositional calculi.
	e calculus, terms, formulas, relational structures, satisfiability, truth, tautologies, axioms, theorems, soundness, model constru		
01MMDY	erbrand theorems. 4.The first and the second Gödel theorems on incompleteness of Peano arithmetics and undecidability of Mathematical Methods in Fluid Dynamics 1	ZK	2
	lations representing the conservation laws of fluid flow are briefly derived and reviewed. Next, the problems for the resulting e		
·	specification. The reference problem undergoes numerical analysis with emphasis on explaining the weak solution and its ro	•	- 1
	ortant problems are introduced, involving fluid flow and other effects (heat transfer, chemical reactions, multiphase nature) an	id an adequate ma	athematical
description is chosen.	Mathematical techniques in his large and medicine	7 71/	2
01MBM Spatially independent m	Mathematical techniques in biology and medicine nodels; enzyme kinetics; excitable system; reaction-diffusion equations; travelling waves; pattern formation; conditions for Turi	Z,ZK	3 effect of domain
	oility in PDEs, spectrum of a linear operator, semigroups.	,,	
01MKP	Finite Element Method	ZK	3
	o the mathematical theory of the finite element method numerically solving boundary-value and initial-boundary-value problen	ns for partial differe	ential equations.
	and the constituent are complete at The composition are continuous and desired		
	s of the method are explained. The approximation error estimates are derived. Monte Carlo Method	7 7K	
18MEMC	Monte Carlo Method the numerical method Monte Carlo and to its selected applications.	Z,ZK	4
18MEMC This courseis devoted to 01MRMMI	Monte Carlo Method the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices	KZ	2
18MEMC This courseis devoted to 01MRMMI The course is aimed at	Monte Carlo Method the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will cov	KZ ver the decomposi	2 tion theory for
18MEMC This courseis devoted to 01MRMMI The course is aimed at	Monte Carlo Method the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices	KZ ver the decomposi	2 tion theory for
18MEMC This courseis devoted to 01MRMMI The course is aimed at symmetric and positive	Monte Carlo Method the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will condefinite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods	KZ ver the decomposi and common imp	2 tion theory for
18MEMC This courseis devoted to 01MRMMI The course is aimed at symmetric and positive issues will be covered. 01NEUR1	Monte Carlo Method the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will cov	KZ ver the decomposi	2 tion theory for lementation
18MEMC This course is devoted to 01MRMMI The course is aimed at symmetric and positive issues will be covered. 01NEUR1 Keywords: Neural networds.	Monte Carlo Method of the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will condefinite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods Neural Networks and their Applications 1 orks, data separation, functional approximation, supervised learning Object Oriented Programming	KZ ver the decomposi and common imp	2 tion theory for lementation
18MEMC This courseis devoted to 01MRMMI The course is aimed at symmetric and positive issues will be covered. 01NEUR1 Keywords: Neural networds. 180OP This course consists of	Monte Carlo Method of the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will covidefinite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods Neural Networks and their Applications 1 orks, data separation, functional approximation, supervised learning Object Oriented Programming the contributions of students concerning given topics concerned on technologies uded in program development.	KZ ver the decomposi and common imp ZK Z	2 tion theory for lementation 2
18MEMC This courseis devoted to 01MRMMI The course is aimed at symmetric and positive issues will be covered. 01NEUR1 Keywords: Neural networds and the course consists of 01PNL	Monte Carlo Method of the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will covidefinite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods Neural Networks and their Applications 1 orks, data separation, functional approximation, supervised learning Object Oriented Programming the contributions of students concerning given topics concerned on technologies uded in program development. Advanced Methods of Numerical Linear Algebra	KZ ver the decomposi and common imp ZK Z ZK	2 tion theory for lementation 2 2 2
18MEMC This courseis devoted to 01MRMMI The course is aimed at symmetric and positive issues will be covered. 01NEUR1 Keywords: Neural networds: Neural netword	Monte Carlo Method of the numerical method Monte Carlo and to its selected applications. Methods for Sparse Matrices utilization of sparse matrices in direct methods for solution of large systems of linear algebraic equations. The course will covidefinite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods Neural Networks and their Applications 1 orks, data separation, functional approximation, supervised learning Object Oriented Programming the contributions of students concerning given topics concerned on technologies uded in program development.	KZ ver the decomposi and common imp ZK Z ZK ty of an algorithm.	tion theory for lementation 2 2 We will analyse
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O1TIN Information Theory
Information Theory
Information Theory
Information theory explores the fundamental limits of the representation and transmission of information. We will focus on the definition and implications of (information) entropy, the source coding theorem, and the channel coding theorem. These concepts provide a vital background for researchers in the areas of data compression, signal processing, controls, and pattern recognition.

O1TEMA Matrix Theory
The subject deals mainly with: 1) similarity of matrices and canonical forms of matrices 2) Perron-Frobenius theory and its applications 3) tensor product 4) Hermitian and positive semidefinite matrices

List of courses of this pass:

Code	Name of the course	Completion	Credits
01ASM	Application of Statistical Methods	KZ	2
The course focus	es on applications of selected methods of statistical data analysis to concrete problems including their solutions using statistical softw	vare. Namely we wi	II deal with:
	neses tests about parameters of normal distribution, nonparametric methods, contingency tables, linear regression and correlation, are	nalysis of variance.	
01ASY	Asymptotical Methods	Z,ZK	3
Examples. Addit	ion parts of mathematical analysis (generalized Lebesgue integral, parametric integrals.) Asymptotic relations a expansions - properti	es; algebraical and	analytical
	operations. Applied asymptotics of sequences and sums; integrals of Laplace and Fourier type.		
01DISE	Diploma Seminar	Z	1
In the first part of	he seminar, students familiarize themselves with the general principles of publishing and presenting scientific work and the formal rec	uirements for diplo	ma 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 curre	nt state of the rese	arch 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 improvin	ng the student's pe	rformance.
01DIZO	Digital Image Processing	ZK	4
image sampling a	nd quantization, Shannon theorem, aliasing basic image operations, histogram, contrast stretching, noise removal, image sharpening l	inear filtering in the	spatial and
frequency domain	s, convolution, Fourier transform edge detection, corner detection feature detection image degradations and their modelling, inverse a	and Wiener filtering	, restoration
	of motion-blurred and out-of-focus blurred images image segmentation mathematical morphology image registration and mate	ching	
01DPAA1	Master Thesis 1	Z	10
	ct is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the pro	ject supervisor duri	_
	regular meetings and discussions.		_
01DPAA2	Master Thesis 2	Z	20
	ct is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the pro	ı ject supervisor duri	-
	regular meetings and discussions.		J
01DYNR1	Dynamic Decision Making 1	Z.ZK	3
	nd analysis of intelligent agents (or systems) that behave appropriately in various circumstances are highly demanded (artificial intelligent	1 '	
•	cial modelling, natural language processing, bioinformatics, web search and information retrieval, algorithm design, system design, net	•	•
-	need to reason with uncertain information and limited computational resources. Effective decision making requires the knowledge ab	=	-
	(including the presence of other intelligent agents), . the agent's goals and preferences . the agent's abilities to observe and influence	•	
	ic decision making under uncertainty and computational methods supporting decision-making. The course helps to develop the mathe		
	y involving uncertainty. These skills can serve as the foundation for further study in any application area you choose to pursue and ma	_	
	your everyday life. Course objectives: - Learn the basic ideas and techniques underlying design of intelligent rational agents. A specil		•
-	modelling paradigm Understand state-of-the-art of decision making (DM) Be able to formulate decision making or learning problem	•	
	oplication Be able to understand research papers in the field (main conferences: IJCAI, NeurIPS, AAMAS, ICAART, ICM; main journ		
	- Try out some ideas of your own.		,
01FAN3	Functional Analysis 3	Z,ZK	5
-	functional analysis needed for theory of representations of Lie groups and quantum theory. Compact operators, their ideals, unbounded		_
-	elfadjoint extension of symmetric operators, Stone's theorem, quadratic forms and Bochner integral. The basics of Banach algebras a		, ,
01FIMA	Financial and Insurance Mathematics	ZK	2
011 111111	This course is an introduction to the problems of life and non-life insurance and financial mathematics.		-
01KOAL	Commutative Algebra	ZK	3
	omomorphisms, prime and maximal ideals. 2. Rings of polynomials, symmetric polynomials, irreducibility. 3. Gröbner bases. 4. Polyno	I	_
-	onyonomials, 5. Hilbert's Nullstellensatz, ideals and manifolds, Krull dimension. 6. Fields, extensions, finite fields. 7. Introduction to Gald		
lactorization of p	group and correspondence.	olo tricory, Calois c	Attribition,
011/00		71/	
01KOS	Compressed Sensing	ZK	2
	ntroduce basic concepts of the theory of compressed sensing – an area founded in 2006 in the works of D. Donoho, E. Candes, and Table 1997 of the development of the control of the contro	· · · · · · · · · · · · · · · · · · ·	
•	solutions of underdetermined systems of linear equations. Due to the applications of sparse representations in electric engeneering and its many different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NP as		
	in many different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NP-c		
	s of systems of linear equations. We introduce conditions which ensure also existence of more effective solvers and show, that these		-
Gaussian ianu0M	matrices. As an effective solution method, we will analyze I1-minimization and Orthogonal Matching Pursuit. We will also study stability results with respect to the corruption of measurements and the optimality of the results.	and robustriess of t	ne obtained
01K//CD4		7	2
01KVGR1	Quantum Groups 1	Z	2
-	a was originated in the 80s in the works of professor L. D. Faddeev and the Leningrad school on the inverse scattering method in order	_	
	e many applications in mathematics and mathematical physics such as the classification of nodes, in the theory of integrable systems		
01MAL	Mathematical Logic	Z,ZK	4
Logic is in the sa	me time an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to in	troduce basic notio	n of results
of classical mathe	matical logic. 1. Propositions, evaluation, tautologies, axioms, theorems, soundness, completeness, and decidability of Hilbert and Gen	tzen style propositi	onal calculi.
	redicate calculus, terms, formulas, relational structures, satisfiability, truth, tautologies, axioms, theorems, soundness, model construc		-
theorem C	kalam and Harbrand theorems. 4 The first and the accord Cadel theorems on incompleteness of Doone crithmetics and undecidability	hu of prodicate cala	uduo.

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
l l	ent models; enzyme kinetics; excitable system; reaction-diffusion equations; travelling waves; pattern formation; conditions for Turing i	· .	
	size; the concept of stability in PDEs, spectrum of a linear operator, semigroups.		
01MKP	Finite Element Method	ZK	3
The course is devot	ted to the mathematical theory of the finite element method numerically solving boundary-value and initial-boundary-value problems for	r partial differentia	l equations.
0.414.450.7	Mathematical properties of the method are explained. The approximation error estimates are derived.	71/	
01MMDY	Mathematical Methods in Fluid Dynamics 1	ZK tions are formulate	2
	I equations representing the conservation laws of fluid flow are briefly derived and reviewed. Next, the problems for the resulting equa tions specification. The reference problem undergoes numerical analysis with emphasis on explaining the weak solution and its role ir		- 1
-	rt, important problems are introduced, involving fluid flow and other effects (heat transfer, chemical reactions, multiphase nature) and		I
·	description is chosen.	•	
01MRMMI	Methods for Sparse Matrices	KZ	2
The course is aim	ed 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 po	ositive definite matrices. Theoretic results will be further applied for solution of more general systems. Main features of the methods a	nd common impler	mentation
	issues will be covered.		
01NAH	Theory of Random Processes	ZK	3
The course is devot	ed 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.	nces both weakly a	and strongly
01NELO	Nonlinear Optimization	ZK	4
	ion problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programming th		
	optimization and basic methods for unconstrained and constrained optimization. The lecture is supplemented by illustrative exangle.		
01NEUR1	Neural Networks and their Applications 1	ZK	2
'	Keywords: Neural networks, data separation, functional approximation, supervised learning	'	
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		
formulation). 6. E	lliptic PDE of Second Order. 7. Existence and uniqueness of weak solutions (Lax-Milgram theorem). 8. Regularity of weak solutions.	Relation to the c	alculus of
04504	variations, Poincaré inequality. 10. Maximum principle for classical and weak solutions.	71/	
01PNL	Advanced Methods of Numerical Linear Algebra	ZK	2
•	eal numbers in computers, behaviour of rounding errors during numerical computations, sensitivity of a problem, numerical stability of genvalues of a given matrix and sensitivity of roots of systems of linear algebraic equations. Then, the backward analysis of these pro	-	- 1
-	course is devoted to the methods of QR-decomposition, least squares problem, and to several modern Krylov subspace methods for the		I
, , , , , , , , , , , , , , , , , , , ,	algebraic equations and the Lanczos method for approximation of the eigenvalues of a symmetric square matrix.		
01PSM1	Problem Seminar in Mathematical Analysis	Z	2
This course is a ser	minar in advanced mathematical analysis and its applications. Seminar talks will be delivered by students, department staff, and invite	d quests. There ar	e no exams
	lents will be assigned by some homework and they will give at least one talk per semester. The seminar is held in English and attenda	ance is mandatory.	
01PSM2	Problem Seminar in Mathematical Analysis 2	Z	2
This course is a ser	minar in advanced mathematical analysis and its applications. Seminar talks will be delivered by students, department staff, and invite	Z d quests. There ar	2 e no exams
This course is a ser but stud	minar in advanced mathematical analysis and its applications. Seminar talks will be delivered by students, department staff, and invite lents will be assigned by some homework and they will give at least one talk per semester. The seminar is held in English and attended	Z d quests. There ar ance is mandatory.	2 re no exams
This course is a ser but stud	minar in advanced mathematical analysis and its applications. Seminar talks will be delivered by students, department staff, and invite lents will be assigned by some homework and they will give at least one talk per semester. The seminar is held in English and attendated Student's seminar in mathematics 1	Z d quests. There ar ance is mandatory. Z	2 re no exams
This course is a ser but stud 01SMS1 01SMS2	minar in advanced mathematical analysis and its applications. Seminar talks will be delivered by students, department staff, and invite lents will be assigned by some homework and they will give at least one talk per semester. The seminar is held in English and attended Student's seminar in mathematics 1 Student's seminar in mathematics 2	Z d quests. There ar ance is mandatory. Z Z	e no exams
This course is a ser but stud 01SMS1 01SMS2 01SPEC	minar in advanced mathematical analysis and its applications. Seminar talks will be delivered by students, department staff, and invite lents will be assigned by some homework and they will give at least one talk per semester. The seminar is held in English and attendated and the seminar in mathematics 1 Student's seminar in mathematics 2 Geometrical Aspects of Spectral Theory	Z d quests. There ar ance is mandatory. Z Z Z ZK	2 e no exams 2 2 2 2
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01TRE2	Representation theory 2	ZK	5
1. Basics of repre	sentations of compact groups, Schur's lemma, orthogonality relations, Casimir operators. 2. Lie groups and algebras, matrix groups,	one parametric s	ubgroups,
	oup SU(n) and their representations. 3. Decomposition of representations, Clebsh-Gordan coeficients. 4. Gelfand-Tsetlin bases, Vern	•	
	al functions. 6. Classification of irreducible representations of semisimple Lie algebras, Cartan subalgebra, roots, weights, lattices, We	·=	Classical and
	eptional simple Lie algebras, Dynkin diagrams. 8. Realizations of Lie algebras, Weyl algebras. 9. Representations of Lie superalgerba		
01UMIN	Probabilistic Models of Artificial Intelligence	KZ	2
The course is dev	oted to the survey of methods used for uncertainty processing in the field of artificial inteligence. The main attention is paid to so-calle particularly to Bayesian networks.	ed graphical Mark	ov models,
01URG	Introduction to Riemannian geometry	ZK	2
	ended for an advanced undergraduate having possibly (but not necessarily) already taken a basic course on topological and differen		1
understanding the	eometric meaning of curvature and its intimate relationship to topology, the student will learn the basic apparatus of Riemannian geor	netry suitable for f	further study
of modern parts	of mathematics and mathematical physics. Possible extension of this lecture is the geometric analysis of partial differential equations	on Riemannian n	nanifolds.
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 of	lifferential equatio	ns is not
straightforward. For	example in the case of heat equation the matrix is replaced by Laplace operator which is not bounded and the series for the exponential	al will not converg	e. Moreover,
	at equation exist in general only for positive times and hence the solution operator can be at best a semigroup. The aim of the course	=	
	or these types of problems and extend the concept of stability from ordinary differential equations, which is again in relation to spectru		1
01VAM	Variational Methods	ZK	3
The course is devot	ed to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or mo	onotonicity. Furthe	er, it contains
	investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.		
01VUAA1	Research Project 1	Z	6
The research proje	t is based on a topic approved by the administrators of the programme and by the head of the de-partment. The student is guided by common regular meetings and discussions	the project super	rvisor during
01VUAA2	Research Project 2	KZ	8
	et is based on a topic approved by the administrators of the programme and by the head of the de-partment. The student is guided by		_
. ,	common regular meetings and discussions.	. , .	Ü
01ZASIG	Analysis and Processing of Diagnostic Signals	ZK	3
0.2.10.0	Digital signal processing, signal transformations and filtrations, spectral and time-frequency analysis		'
02ALT	Algebraic Topology	Z.ZK	4
-	nathematical and theoretical physics requires one to acquire an ever increasing knowledge of mathematical apparautus. The main go	,	1 -
=	methods used in algebraic topology, namely elements of category theory, homototopies, homological algebra and cohomology. An imp		
	anguage by concepts appearing universally across disciplines like differential geometry and abstract algebra. During excercise session	=	
	calculations of introduced mathematical structures.		
02COX	Coxeter Groups	Z	2
The course is an i	troduction to the theory of Coxeter groups and their invariant theory. The case of the finite Coxeter groups - the reflection groups and		
	ell the control of the corresponding bilinear forms and the theory of their classics.	their properties a	
generalization of t			are studied.
	ne reflection groups. The study of affine Weyl groups and related objects forms basic example of infinite Coxeter groups. As an introd	assification repres	are studied. sent abstract
	ne reflection groups. The study of affine Weyl groups and related objects forms basic example of infinite Coxeter groups. As an introd the MacDonald identity and the Weyl identity are presented.	assification repres	are studied. sent abstract
02KFA		assification repres	are studied. sent abstract
02KFA	the MacDonald identity and the Weyl identity are presented.	assification represuction to the invar	are studied. sent abstract riant theory
02KFA The goal of the lect	the MacDonald identity and the Weyl identity are presented. Quantum Physics	assification represuction to the invar Z,ZK is of bounded and	are studied. sent abstract riant theory 6 I unbounded
02KFA The goal of the lect	the MacDonald identity and the Weyl identity are presented. Quantum Physics ure is formulating and developing quantum theory as a physically motivated, but mathematically rigorous theory built upon the analysis	assification repres uction to the invar Z,ZK is of bounded and vot point is the es	are studied. sent abstract riant theory 6 I unbounded tablishing of
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