BG8 Numerics I

Module name	Numerics I
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … know how to implement algorithms in computer programs, … are able to solve large systems of equations and have knowledge about interpolation techniques and error analysis
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Introduction to fundamental numerical linear algebra: Consistence, Convergence, Condition, Solution of systems of linear equations by means of direct methods: Gaussian elimination, LU decomposition, Cholesky decomposition, QR decomposition, Statements on existence and uniqueness of iterative methods: General splitting methods, Jacobi methods, Gauß-Seidel method, consistence, convergence, rate of convergence Polynomial interpolation: Statements on existence an uniqueness, Lagrangian interpolation, Neville scheme, Newton interpolation, error analysis
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of analysis and linear algebra
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BG9 Stochastics I

Module name	Stochastics I
Learning outcomes	Students … are able to describe coincidence with probability spaces and random variables in a mathematical way. … know how to compute probabilities and characteristic variables of distributions. … are able to model and solve basic stochastic problems.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Discrete probability spaces, random variables and their distributions, conditional probability, stochastic independence, mathematical expectation and variance, weak law of large numbers, continuous distributions
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Analysis
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (120 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	N.N.
Instructors	All instructors of the department
Media	Board, projector, Moodle, assignments

BW1 Algebraic topology

Module name	Algebraic topology
Learning outcomes	Students … know important structures of algebraic topology, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms … are able to solve problems in algebraic topology.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Homotopy, fundamental group, covering space, simplicial and singular homology.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW2 Approximation theory

Module name	Approximation theory
Learning outcomes	Students learn …the fundamentals of approximation theory, …acquire understanding for the relation between order of convergence and smoothing and knowledge of fundamental approximation methods
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Fundamentals of functional analysis, best approximation, linear methods, trigonometric kernels, modulus of continuity, singular integrals, Banach-Steinhaus theorem, interpolation, stability estimates.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, functional analysis
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW3 Coding theory

Module name	Coding theory
Learning outcomes	Students … know important structures of coding theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in coding theory using mathematical methods
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Error correcting block codes, theory of safety (Shannon's theorem), linear codes, bounds of block codes, cyclic codes, BCH codes, algebraic geometry codes, decoding methods.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, Moodle, assignments.

BW4 Computer algebra I

Module name	Computer algebra I
Learning outcomes	Students … know important structures and methods of computer algebra. … have fundamental solution solving competencies. … are able to understand and formulate basic algebraic algorithms, … are able to work out simple unknown mathematical issues and algorithms on their own, … know how to use computer algebra systems in first algorithms and for solving more complex problems in algebra.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Possibilities of general-purpose computer algebra systems, programming in computer algebra systems, integer and polynomial arithmetic, extended Euclidean algorithm and applications, factorization of integers, factorization of polynomials.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Linear algebra I
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks

BW5 Differential geometry

Module name	Differential geometry
Learning outcomes	Students … know important basic concepts of Differential geometry. … have fundamental solution solving competencies. … understand geometric proofs and can formulate them on their own, … are able to work out simple unknown mathematical issues and algorithms on their own, … are able to solve geometric problems.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Manifolds, coordinate charts, local coordinates, tangent spaces, vector fields, distributions, cotangent spaces, differential forms.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Analysis I, II
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW6 Elementary algebraic geometry

Module name	Elementary algebraic geometry
Learning outcomes	Students … know important structures of algebraic geometry, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve elementary problems in algebraic geometry.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Connection between commutative algebra and algebraic geometry, irreducible variety, tangent space, singularities, elimination theory
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW7 Elementary number theory

Module name	Elementary number theory
Learning outcomes	Students … know important structures of number theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in number theory.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Natural numbers and integers, divisibility, gcd and Euclidian algorithm, prime numbers, congruences and Chinese remainder theorem, structure of multiplicative groups of integers modulo n.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW8 Complex analysis

Module name	Complex analysis
Learning outcomes	Students have basic knowledge of … the theory of holomorphic functions with one variable, … application of complex analysis to other domains in mathematics and mathematical physics
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Holomorphic functions, power series, Cauchy's integral theorem, Laurent series, Riemann's theorem on removable singularities, essential singularities.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW9 Galois theory

Module name	Galois theory
Learning outcomes	Students … know important structures of group and field theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in Galois theory.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Normal and separable field extensions, fundamental theorems of Galois theory, continuation of group theory, solving equations into radicals, compass-and-straightedge construction.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW10 Ordinary differential equations

Module name	Ordinary differential equations
Learning outcomes	Students ... acquire knowledge of the fundamental concepts, statements and methods of the theory of ordinary differential equations, ... are able to precisely formulate mathematical problems and to justify them logically, ... know how to use results from basic modules to solve problems in ordinary differential equations, ... have understood the relevance of ordinary differential equations for multiple applications.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Classical existence and uniqueness theorems, specific solution methods, linear systems, introduction to qualitative aspects: phase portrait, stability.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, elementary linear algebra, linear algebra and analytical geometry
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW11 Gröbner bases

Module name	Gröbner bases
Learning outcomes	Students … know important structures of commutative algebra, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve algebraic problems using Gröbner bases.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Polynomial ideals, quotient ring, Gröbner bases, Buchberger's algorithm, elementary applications, syzygies, elimination theory.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW12 Hilbert space methods

Module name	Hilbert space methods
Learning outcomes	Students learn basic concepts of Hilbert spaces and their geometry as well as selected applications. They know about the abstract conception of functions being seen as points inside a function space.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Hilbert spaces, orthonormal bases and bounded linear operators between Hilbert spaces: theory and examples. Applications: Boundary and eigenvalue problems of differential equations, integral transforms.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, functional analysis, partial differential equations
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW13 Integral equations

Module name	Integral equations
Learning outcomes	Students learn how to formulate and classify integral equations in standard form, to analyze integral equations for existence and uniqueness, to formulate application examples as integral equations.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Riesz and Fredholm theory, Fredholm and Volterra equations of first and second type, applications in potential theory.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, vector analysis, functional analysis
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW14 Cryptography

Module name	Cryptography
Learning outcomes	Students … know important structures of cryptography, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in cryptography using mathematical methods.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Introduction to encryption and decryption, historical examples, symmetric cryptography, public-Key cryptography
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW15 Linear systems theory

Module name	Linear systems theory
Learning outcomes	Students … know important structures of linear systems theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in linear system theory.
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Basic concepts of linear systems, stability, reachability and controllability, feedback, observer and observability.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Linear algebra, ordinary differential equations
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW16 Numerics II

Module name	Numerics II
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … know how to implement algorithms in computer programs, … are able to solve non-linear equation systems, linear least squares problems and eigenvalue problems and are able to perform numerical integration
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Numerical integration: quadrature based on interpolating functions and error analysis, non-linear systems of equations: Newton's method and its modifications, linear least squares: minimization and normal equations, eigenvalue problems: bounds for the spectrum of matrices, power iteration, QR algorithm.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of numerics (numerics I)
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	Written exam (90 – 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BW17 Potential theory

Module name	Potential theory
Learning outcomes	Students learn to compute fundamental solutions, to explicate concepts of potential theory in theory and in applications, to develop proof sketches to the main theorems and to recognize the connection to complex analysis.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Properties of harmonic functions and potentials, Green's functions, boundary value problems for Laplace's equation.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, vector analysis, functional analysis
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW18 Sobolev spaces

Module name	Sobolev spaces
Learning outcomes	Students … have knowledge of the basic concepts and methods of applied analysis. … have fundamental solution solving competencies. … have basic knowledge of the theory of Sobolev spaces. … are able to recognize important ideas of applied analysis and to apply them to related problems
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Weak derivatives versus strong derivatives, Hölder norms, approximation with smooth functions, embedding theorems, trace theorems, Poincaré inequality.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, basic knowledge of submanifolds
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BW19 Stochastics II

Module name	Stochastics II
Learning outcomes	Students … are able to describe coincidence in complex situations mathematically. … have knowledge of basic stochastic processes.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Conditional probability, parameters of continuous distributions, central limit theorem, convolution, multidimensional normal distribution, branching process, Markov chains,basic ideas of test and estimation theory.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, linear algebra, stochastics I
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, projector, Moodle, assignments.

BW20 Topology

Module name	Topology
Learning outcomes	Students … have knowledge of the fundamental concepts of topology.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Sets and orders, metric spaces, Banach fixed-point theorem, topological spaces, continuous mappings and compactness, separation, locally compact spaces and compactification, product topology, normal spaces, metrization, Stone-Weierstrass theorem, topological dimension, Hausdorff distance
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, linear algebra
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, notes, assignments.

BW21 Vector analysis

Module name	Vector analysis
Learning outcomes	Students learn … the fundamental concepts of differential geometry … how to transfer the terms they learned in the analysis basic class (continuity, differentiation, integration) from local objects (e.g. open sets in Rn) to manifolds
Type of contact hours	Lecture: 2 SWS Discussion: 1 SWS
Contents	Manifolds and submanifolds, curves and surfaces in space and their local geometry, geodasic, topological terms on manifolds, Gauss's theorem and Stoke's theorem.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV1 Abstract algebraic geometry

Module name	Abstract algebraic geometry
Learning outcomes	Students … know important structures of modern algebraic geometry, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in algebraic geometry.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Categories and functors, sheafs, schemes, vector bundles.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra) and commutative algebra
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV1 Algebraic curves and their function fields

Module name	Algebraic curves and their function fields
Learning outcomes	Students … know important structures of algebra and algebraic geometry, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in algebraic curves.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Affine algebraic curves and their function fields, projective closure, singularities, intersection theory, algebraic function fields in one variable, Riemann-Roch theorem, applications in coding theory.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV2 Algebraic system theory

Module name	Algebraic system theory
Learning outcomes	Students … know important structures of algebraic system theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in algebraic system theory.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Abstract linear systems, fundamentals of systems theory, one-dimensional systems, multi-dimensional systems, fundamentals of homological algebra.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV4 Algorithms for power and Fourier series

Module name	Algorithms for power and Fourier series
Learning outcomes	Students … know important structures of computer algebra. … have fundamental solution solving competencies. … understand and formulate algorithms. … are able to work out unknown mathematical issues and algorithms on their own. … know how to apply computer algebra systems to algorithms and to solve complex algebraic problems.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Simplifications and canonical forms, Taylor polynomials and power series, Petkovsek's algorithm, Fourier polynomials and series.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Linear algebra I, desirable: computer algebra I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (2 - 3 h) or alternatively oral exam (30 - 45 min.) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks

MV5 Algorithmic algebraic geometry

Module name	Algorithmic algebraic geometry
Learning outcomes	Students … know important structures of algebra and algebraic geometry, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in algebraic geometry algorithmically.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Variety, Zariski topology, decomposition in irreducible components, normalization, dimension theory.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra), Gröbner bases
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV6 Algorithmic algebraic number theory

Module name	Algorithmic algebraic number theory
Learning outcomes	Students … know important structures of algebra and number theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in algebraic number theory algorithmically.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Quadratic fields, algebraic number fields, Rings of integers and class groups, structure of the unit group, algorithms for the computation of the invariants of a number field.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV7 Algorithmic homological algebra

Module name	Algorithmic homological algebra
Learning outcomes	Students … know important structures of homological algebra, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in homological algebra algorithmically.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Projective and injective modules, resolutions, computation of free resolutions, categories and functors, derived functors, Koszul complex, computation of ext and tor.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra), Gröbner bases
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV3 Algorithmic commutative algebra

Module name	Algorithmic commutative algebra
Learning outcomes	Students … know important structures of algebra and algebraic geometry, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in commutative algebra constructively.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Connection between commutative algebra and algebraic geometry, Gröbner bases, syzygies, dimension theory, elimination theory, Hilbert functions, resolutions.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV4 Algorithmic number theory

Module name	Algorithmic number theory
Learning outcomes	Students … know important structures of algebra and number theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in number theory algorithmically.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Factoring algorithms for polynomials over finite fields, lattices, LLL lattice basis reduction algorithm, units in algebraic number fields, solution of normal equations.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV5 Applied statistics

Module name	Applied statistics
Learning outcomes	Students … are able to describe and interpret emirical issues using descriptive statistical measures and graphical representations. … have knowledge of the fundamental methods of statistics.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Descriptive statistics, estimators, various distributions, interval estimates, tests, regression analysis, discriminant function analysis, principal component analysis.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, algebra, stochastics I, stochastics II
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, assignments.

MV11 Asymptotic methods in fluid mechanics

Module name	Asymptotic methods in fluid mechanics
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natrural sciences, technology and economy, … have solution solving competencies, … are able to apply asymptotic expansions in a problem-oriented way
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Landau notation, asymptotic sequences and asymptotic expansions, expansions for ordinary differential equations, expansions for singularly perturbed problems, single scale and multiple scale expansions for partial differential equations.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis as well as ordinary and partial differential equations
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV6 Computer algebra II

Module name	Computer algebra II
Learning outcomes	Students … have knowledge of important principles and methods of computer algebra. … have fundamental solution solving competencies. … are able to understand algebraic algorithms and know how to formulate them on their own. … are able to work out unknown mathematical issues and algorithms on their own. … know how to use computer algebra systems in first algorithms and for solving more complex problems in algebra.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Algebraic numbers, simplifications and canonical forms, Taylor polynomials and power series, algorithmic summation, algorithmic integration.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Linear algebra I, desirable: computer algebra I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (2 - 3 h) or alternatively oral exam (30 - 45 min.) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks

MV13 Computer algebra and orthogonal polynomials

Module name	Computer algebra and orthogonal polynomials
Learning outcomes	Students … know important structures and methods of computer algebra. … have knowledge of classical systems of orthogonal Askey-Wilson polynomials. … have fundamental solution solving competencies. … are able to understand algebraic algorithms and can formulate them on their own. … are able to work out unknown mathematical issues and algorithms on their own. … know how to use computer algebra systems in algorithms and for solving complex problems concerning orthogonal polynomials.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Gamma function, hypergeometric functions and identities, hypergeometric database, Fasenmyer algorithm, properties of orthogonal functions and polynomials, orthogonal polynomials (Hermite, Laguerre, Bessel, Jacobi, Gegenbauer, Chebyshev and Legendre), discrete orthogonal polynomials (Charlier, Meixner, Krawchouk and Hahn), q-orthogonal polynomials, Askey-Wilson polynomials.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Linear algebra I, desirable: computer algebra I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (2 - 3 h) or alternatively oral exam (30 - 45 min.) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks or Maple worksheets

MV14 The Navier-Stokes equations

Module name	The Navier-Stokes equations
Learning outcomes	Students acquire thorough analytical knowledge and skills by studying an highly topical problem in fluid dynamics in different variations (linear – nonlinear – steady – nonsteady).
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Modelling, weak and strong solution, global existence of weak solutions, energy inequality, Stokes operator and semi group, short-time existence of strong solutions, uniqueness, Leray's structure theorem.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Partial differential equations, fundamentals of functional analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Active participation in the discussions
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV7 Differential algebra

Module name	Differential algebra
Learning outcomes	Students … know important structures of differential algebra, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems in differential algebra.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Differential rings, differential fields, differential polynomials, differential ideals, fundamental algorithms, applications to systems of partial differential equations.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Werner M. Seiler
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV16 Drinfeld modules

Module name	Drinfeld modules
Learning outcomes	Students … know important structures of algebra and number theory, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems concerning Drinfeld modules.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Finite fields, additive polynomial, Carlitz modules, Drinfeld modules, analytic theory of non-archimedean solids.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV8 Dynamical systems I

Module name	Dynamical systems I
Learning outcomes	Students … got to know dynamical systems in their most general form. … have knowledge of fundamental invariants of dynamical systems.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Measure preserving transformations, recurrence and ergodic theorems, mixing, spectral isomorphy and invariants, transformations with discrete spectrum, torus endomorphisms and countable Lebsegue spectrum, entropy, generator theorem, invariant measure space, variation principle.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, Algebra, measure and probability theory
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, notes, assignments.

MV18 Dynamical systems II

Module name	Dynamical systems II
Learning outcomes	Students … have thorough knowledge of various applications of dynamical systems.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Topological invariants and recurrence, one-dimensional dynamic, multi-dimensional dynamic, symbolic dynamic.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, Algebra, measure and probability theory, dynamical systems I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, notes, assignments.

MV19 Elliptic curves and abelian varieties

Module name	Elliptic curves and abelian varieties
Learning outcomes	Students … know important structures of algebra, number theory and algebraic geometry, … have fundamental solution solving competencies, … understand and formulate mathematical concepts and implement in algorithms, … are able to solve problems concerning elliptic curves and abelian varieties.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Complex one-dimensional tori, elliptic curves over finite and local fields, elliptic curves over global fields, algorithms to compute the Mordell-Weil group, complex multi-dimensional tori and abelian varieties.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of algebra (e.g. fundamentals of algebra and computer algebra)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Hans-Georg Rück
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV9 Elliptic problems

Module name	Elliptic problems
Learning outcomes	Students … have thorough knowledge of elliptical boundary value problems and their applications.… cross-link their mathematical knowledge by establishing complex relationships between applied mathematics and fundamental arguments of functional analysis
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Boundary value problems for the Laplace equation, strong elliptic and Agmon-Douglis-Nirenberg systems, weak solutions, regularity estimates, construction of a parametrix, treatment of singularities at the boundary.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, linear algebra I, vector analysis, esp. integral theorems, Sobolev spaces, fundamentals of functional analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV10 Evolution equations

Module name	Evolution equations
Learning outcomes	Students learn about the fundamental ideas and concepts of the operator-based approach to evolution equations and know how to apply them to partial differential equations.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Strongly continuous one-parameter semigroup and its generators, analytic semigroups, inhomogeneous and semilinear Cauchy problems, applications to partial differential equations.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, partial differential equations, functional analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV22 Factoring algorithms

Module name	Factoring algorithms
Learning outcomes	Students … know important structures and methods of computer algebra. … have fundamental solution solving competencies. … are able to understand algebraic algorithms and can formulate them on their own. … are able to work out unknown mathematical issues and algorithms on their own. … know how to use computer algebra systems in first algorithms and for solving more complex problems in algebra.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Programming in computer algebra systems, introduction to factorization of integers, efficient factorization of integers, introduction to factorization of polynomials, finite fields, efficient factorization of polynomials over finite fields, efficient factorization of integer polynomials.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Linear algebra I, desirable: computer algebra I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Written exam (90 - 150 min) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks

MV23 Finite element methods

Module name	Finite element methods
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … can develop mathematical models, … have knowledge of finite element methods for the problem-oriented solution and analysis of elliptic differential equations, … are able to implement finite element methods in computer programs on their own.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Hilbert space methods for the numerical solution of linear boundary value problems, Ritz-Galerkin method, finite element spaces (construction, properties), interpolation estimates, inverse inequalities, converge theorems.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis and ordinary differential equations. Basic knowledge of solving ordinary differential equations numerically (numerical methods for ordinary differential equations). Desirable: functional analysis.
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Gunar Matthies
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV11 Functional analysis

Module name	Functional analysis
Learning outcomes	Students … acquire thorough knowledge of important structures and methods of analysis. ... learn about the meaning of functional analysis for applications in applied analysis as well as in numerics. … recognize abstraction as the essential tool for simplification and transparency.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Normed vector spaces, linear mappings, Hilbert spaces and their geometry, dual spaces and reflexivity, weak convergence, Baire category theorem, fundamental theorems of operator theory, closed operators, spectra of operators, functional calculus of operators.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, elementary linear algebra, linear algebra, measure theory
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (2-3h) or Oral exam (30-40 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV12 Geometric complex analysis

Module name	Geometric complex analysis
Learning outcomes	Students … know important structures and methods of complex analysis. … have fundamental solution solving competencies. … are able to understand concepts of complex analysis on their own and know how to formulate them. … are able to work out unknown mathematical issues and algorithms on their own. … know how to use computer algebra systems in algorithms and for solving complicated problems in geometric complex analysis.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Riemann mapping theorem and compactness, Bieberbach conjecture, domains bounded by polygons: Schwarz-Christoffel mapping, functions with positive real part, convex and star-like functions, close-to-convex functions, de Branges's theorem, functions of de Branges and Weinstein.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Analysis I, II, desirable: complex analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (2 - 3 h) or alternatively oral exam (30 - 45 min.) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks or Maple worksheets

BV13 Hydrodynamic potential theory

Module name	Hydrodynamic potential theory
Learning outcomes	Students learn to compute fundamental solutions, to explicate the terms of hydrodynamic potential theory, to deliver proof sketches of the representation theorems and to realize the connection between classical potential theory to the Laplace equation.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Derivation and investigation of the fundamental tensor of the hydrodynamic Stokes equations and the resulting vector potentials for the solution of boundary value problems of the Stokes equations.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis, functional analysis, partial differential equations
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (20 - 30 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV27 Interpolation theory

Module name	Interpolation theory
Learning outcomes	Students acquire knowledge of efficient methods to produce specific estimations in scales of particular Banach spaces.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Complex interpolation (Riesz-Thorin interpolations theorems, applications), real interpolation (Marcinkiewicz interpolation theorem, Lorentz spaces, Bessel potential spaces), applications (asymptotics and regularity of solutions of evolution equations, positive operators and their interpolation scale, fractional powers).
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Partial differential equations, fundamentals in functional analysis, Sobolev spaces
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Active participation in the discussions
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV14 Introduction to parallel computing

Module name	Introduction to parallel computing
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy. … have solution solving competencies, … are able to implement algorithms in computer programs on their own, … are able to perform basic parallelization of numerical software.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	This course will introduce the basic aspects of parallel programming and the algorithmic considerations involved in designed scalable parallel numerical methods. The programming will use MPI (Message Passing Interface), the most common library of parallel communication commands for distributed-memory clusters. We will also consider the options for multi-threading on multi-core CPUs and for using graphics processing units (GPUs) connected to CPUs. The class will include an efficient introduction to the Linux operating system as installed on the cluster being used, and it will include a review of serial programming in the source code language C that is integrated into the initial presentation of sample codes. Registered students in this course will gain access to state-of-the-art cluster computing resources, for instance at the IT Servicezentrum at the University of Kassel.
Delivery modes	Lecture, seminar, individual and group work
Language	Englisch
Recommended prerequisites	Numerics I
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Matthias Gobbert
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV15 Measure and probability theory

Module name	Measure and probability theory
Learning outcomes	Students … are able to integrate in general measure spaces. … have knowledge of the mindset and techniques of probability theory. … have acquired the preconditions for further studies in stochastics.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Families of sets and measures, integration and product measures, zero-one laws, convergence concepts, laws of large numbers, characteristic functions, central limit theorems, Radon-Nikodym, conditional expectation, uniform integrability.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, algebra, stochastics I, stochastics II
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, notes, assignments.

BV16 Mathematical fracture mechanics

Module name	Mathematical fracture mechanics
Learning outcomes	Students … deepen their knowledge of important structures and methods of applied analysis. … understand the benefit of mathematical methods for problems of high practical relevance. … have solution solving competencies.
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	Mathematical methods in the context of crack propagation: energy criterion, different parts of energy, formulation as variational inequality, methods of asymptotical analysis.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Partial differential equations, fundamentals of functional analysis, Kenntnisse in Numerics
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Active participation in the discussions
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MV31 Mathematical methods in continuum mechanics

Module name	Mathematical methods in continuum mechanics
Learning outcomes	Students … deepen their knowledge of important structures and methods of applied analysis, especially regarding particular function spaces and projections in mathematical continuum mechanics. …. have understood some fundamental methods for solving nonlinear problems and and are able to apply them to related problems.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Special function spaces, variants of Helmholtz decomposition, mathematical methods for the solution of problems from fluid mechanics (e.g. Stokes and Navier-Stokes) and solid mechanics (e.g. linear and nonlinear elasticity).
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Partial differential equations, fundamentals of Functional analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Active participation in the discussions
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV17 Mathematical statistics

Module name	Mathematical statistics
Learning outcomes	Students … have knowledge of the theoretical background of miscellaneous methods of inductive statistics.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Parameter estimation, interval estimation, hypothesis testing, Neyman-Pearson lemma, isotonic density ratios, exponential families, improper prior probability, sufficient statistics and completeness, Bayes methods for sequential testing.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Measure and probability theory
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, assignments.

MV33 Numerical methods for differential algebraic equations

Module name	Numerical methods for differential algebraic equations
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy. … have solution solving competencies, … are able to to solve and analyze differential algebraic equations in a problem-oriented way.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Examples of differential-algebraic equations (DAEs), Index of a DAE, numerical methods for DAEs, consistency, stability and convergence.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis and ordinary differential equations. Basic knowledge of solving ordinary differential equations numerically (numerical methods for ordinary differential equations).
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV18 Numerical methods for ordinary differential equations

Module name	Numerical methods for ordinary differential equations
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … are able to implement algorithms in computer programs on their own, … have knowledge of the analysis and application of One-step and multi-step methods
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Ordinary differential equations modelling real life applications, geometric interpretation (line elements, slope field, isoclines), integration and differentiation schemes, one-step and multi-step methods, consistency, stability and convergence.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of analysis and linear algebra. Profound knowledge of numerics (numerics I and numerics II).
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV19 Numerical methods for systems of linear equations

Module name	Numerical methods for systems of linear equations
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … are able to implement algorithms in computer programs on their own, … have knowledge of solving large sparse ill-conditioned systems of equations efficiently.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Direct and iterative methods, splitting schemes, multigrid methods, Krylov subspace methods, preconditioning.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Fundamental knowledge of analysis and linear algebra. Profound knowledge of numerics (numerics I and numerics II).
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

MV35 Numerical methods for partial differential equations

Module name	Numerical methods for partial differential equations
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … are able to develop mathematical models, … are able to to solve and analyze partial differential equations in a problem-oriented way.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Classification of partial differential equations, Laplace equation, wave equation, heat equation, Reynolds transport theorem and derivation of the conservation laws of fluid mechanics, finite difference schemes, finite element schemes, finite volume schemes, consistency, stability and convergence.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis and ordinary differential equations. Fundamental experience in solving ordinary and partial differential equations numerically (numerical methods for ordinary differential equations)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

MV36 Numerical methods for stiff problems

Module name	Numerical methods for stiff problems
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … are able to implement algorithms in computer programs on their own, … have knowledge of solving stiff problems bearing upon real applications.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Characterisation of stiff problems, numerical methods for initial value problems (stability, consistency and convergence, time adaptivity), numerical methods for non-linear systems equations, numerical methods for linear systems of equations.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis and ordinary differential equations. Fundamental experience in solving ordinary differential equations numerically (numerical methods for ordinary differential equations)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Andreas Meister
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

MV37 Computational fluid dynamics

Module name	Computational fluid dynamics
Learning outcomes	Students … have fundamental skills to solve mathematical problems. … have solution solving competencies, … are able to develop mathematical models … are able to solve and analyze partial differential equations in a problem-oriented way … acquire basic knowledge of solving the incompressible Navier-Stokes equations numerically using finite element methods
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Incompressible Stokes and Navier-Stokes equations, function spaces, decomposition of vector fields, saddle point problems, inf-sup stable finite elements, application to Stokes equations, stabilization for high Reynolds numbers, unsteady problems.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis and partial differential equations, finite element methods.
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Gunar Matthies
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

MV38 Semi-groups of operators

Module name	Semi-groups of operators
Learning outcomes	Acquisition of knowledge of a function analytical approach to important evolution equations of mathematical physics like the heat conduction equation, the Schrödinger equation and the wave equation
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Strongly continuous one-parameter semigroups and their generators, Hille-Phillips-Yosida theorem, dissipativity, analytic semigroups, Trotter-Kato-Yoshida approximation theorems, heat kernels and convolution semigroups, asymptotics and regularity.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Partial differential equations, fundamentals of functional analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Active participation in the discussions
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Werner Varnhorn
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV20 Optimization

Module name	Optimization
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy. … have solution solving competencies, … have knowledge of modeling of optimization problems, … have knowledge of structural and algorithmic principles of optimization, … know fundamental algorithms of graph theory, … are able to translate structural perceptions into practical calculation methods
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Linear optimization (duality, integer programs), graph theory (characterization of graphs, shortest paths, network flow), non-linear optimization (convexity, separation theorems, projection methods).
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Basic knowledge of analysis and linear algebra, introduction to optimization
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Gunar Matthies
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV21 Parallel computing for partial differential equations

Module name	Parallel computing for partial differential equations
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy, … have solution solving competencies, … are able to implement algorithms in computer programs on their own, … have knowledge of parallelization of numerical methods for solving partial differential equations
Type of contact hours	Lecture: 2 SWS Discussion:1 SWS
Contents	An important application of parallel computing is in the area of numerical methods for partial differential equations. This course will introduce methods for the elliptic Poisson equation and the parabolic reaction-diffusion equation as examples. The class will include an efficient introduction to the Linux operating system as installed on the cluster being used, and it will include a review of serial programming in the source code language C that is integrated into the initial presentation of sample codes. The programming will use MPI (Message Passing Interface), the most common library of parallel communication commands for distributed-memory clusters. We will also consider the options for multi-threading on multi-core CPUs and for using graphics processing units (GPUs) connected to CPUs. Registered students in this course will gain access to state-of-the-art cluster computing resources, for instance at the IT Servicezentrum at the University of Kassel.
Delivery modes	Lecture, seminar, individual and group work
Language	Englisch
Recommended prerequisites	Numerics I. Fundamental knowledge of parallelization (introduction to parallel computing)
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	written exam (90 – 150 min.) or alternatively Oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Matthias Gobbert
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV22 Partial differential equations

Module name	Partial differential equations
Learning outcomes	Students ... know the three different fundamental types of linear partial differential equations of second order ... develop an understanding for what physical phenomena can be described thereby ... have knowledge of fundamental techniques in handling partial differential equations (e.g. the maximum principle) and know how to use them in arguments
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Linear partial differential equations of first order, classification of partial differential equations of second order, derivation of fundamental solutions and integral representation of solutions, local existence theorems, Cauchy–Kovalevskaya theorem, (power series ansatz), weak solutions and energy methods.
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	English
Recommended prerequisites	Analysis I, II, linear algebra I, vector analysis, esp. Integral theorems
Student workload	Lecture (2 SWS): 30 h Discussion (1 SWS): 15 h Self-study: 105 h Total: 150 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Regular submission of the assignments
Exam requirements	Oral exam (30 - 40 min)
Module coordinator	Prof. Dr. Maria Specovius-Neugebauer
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

BV23 Stochastic processes I

Module name	Stochastic processes I
Learning outcomes	Students … got to know the most important fundamental processes and their properties.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Introduction to stochastic processes, Kolmogorov existence theorem, Markov processes, Poisson processes, martingales, stopping time, convergence theorems for martingales, optimal stopping theorems, Brownian motion, constructions and properties, strong Markov property, path properties, zero-one laws, reflection principle, law of the iterated logarithm, outlook: stochastic integrals and Ito calculus.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Analysis, linear algebra, stochastics I, stochastics II, measure and probability theory
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, assignments.

MV42 Stochastic processes II

Module name	Stochastic processes II
Learning outcomes	Students … have acquired thorough knowledge of stochastic processes.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Stochastic analysis, martingales in continuous time, semimartingales, Doob-Meyer decomposition, quadratic variation, stochastic integration with respect to martingales and Brownian motion, Ito's lemma, martingale representation theorem, Girsanov theorem, stochastic differential equations, diffusions, connection between Markov processes and martingale problems, applications.
Delivery modes	Lecture, seminar, individual and group work.
Language	English
Recommended prerequisites	Stochastic processes I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, further details will be specified by the instructor.
Requirement for admission to exam	Successful completion of the study requirements.
Exam requirements	Written exam 2 h or oral exam 20-30 min. The type of exam will be chosen by the instructor.
Module coordinator	??? ??? ???
Instructors	All instructors of the department
Media	Board, Moodle, assignments.

BV24 Summation algorithms

Module name	Summation algorithms
Learning outcomes	Students … know important structures and methods of Computer algebra. … have fundamental solution solving competencies. … are able to understand algebraic algorithms and can formulate them on their own. … are able to work out unknown mathematical issues and algorithms on their own. … know how to use computer algebra systems in first algorithms and for solving more complex problems in algebra.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Gamma function, hypergeometric functions and hypergeometric identities, hypergeometric database, Fasenmyer algorithm, multiple summation, Gosper algorithm, Zeilberger algorithm, Petkovsek algorithm.
Delivery modes	Lecture, discussions
Language	English
Recommended prerequisites	Linear algebra I, desirable: computer algebra I
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	written exam (2 - 3 h) or alternatively oral exam (30 - 45 min.) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Wolfram Koepf
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments, Mathematica notebooks or Maple worksheets

MV44 Theory and numerical methods for singular perturbation problems

Module name	Theory and numerical methods for singular perturbation problems
Learning outcomes	Students … have basic knowledge of solving mathematical problems arising from natural sciences, technology and economy. … have solution solving competencies, … are able to develop mathematical models, … are able to solve and analyze singular perturbation problems in a problem-based way
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Characterisation of singularly perturbed differential equations, methods of asymptotic analysis, solution estimates, construction of adapted numerical schemes, stability and convergence.
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	Profound knowledge of analysis, ordinary differential equations and numerics (numerics I and numerics II).
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Regular submission of assignments, at least 50% of the total score
Requirement for admission to exam	none
Exam requirements	Written exam (90 – 150 min.) or alternatively oral exam (20 - 30 min) The type of the exam will be chosen by the instructor.
Module coordinator	Prof. Dr. Gunar Matthies
Instructors	All instructors of the department
Media	Board, projector, notes, assignments

BV25 Calculus of variations with applications to partial differential equations

Module name	Calculus of variations with applications to partial differential equations
Learning outcomes	Students … deepen their knowledge of important structures and methods of applied analysis. … understand the benefit of mathematical methods for problems of high practical relevance. … have solution solving competencies.
Type of contact hours	Lecture: 4 SWS Discussion: 2 SWS
Contents	Minimization of functionals that are defined on infinite dimensional Banach spaces. Classical Method: Minimizing a functional versus solving the Euler-Lagrange equations, local/global minimizers, necessary and sufficient conditions for weak/strong local Minimizers, different types of convexity (quasi/rank-one-convexity); direct method in the calculus of variations: functional analytic methods and existence of global minimizers, weakly lower semi-continuous functionals; application to partial differential equations
Delivery modes	Lecture, seminar, individual and group work, problem-based learning (PBL)
Language	German or English
Recommended prerequisites	Analysis I, II, linear algebra, measure theory, functional analysis
Student workload	Lecture (4 SWS): 60 h Discussion (2 SWS): 30 h Self-study: 210 h Total: 300 h
Study requirements	Active participation in the discussions
Requirement for admission to exam	Successful completion of the study requirements
Exam requirements	Oral exam (30-40 min)
Module coordinator	Prof. Dr. Dorothee Knees
Instructors	All instructors of the department
Media	Board, projector, Moodle, notes, assignments

MK7 Mathematical software – MATLAB

Module name	Mathematical software – MATLAB
Learning outcomes	Students … have basic knowledge of MATLAB … are able to work on mathematical problems with MATLAB
Type of contact hours	Lecture: 2 SWS Discussion: 2 SWS
Contents	The course aims at providing basic knowledge of MATLAB with an emphasis on efficient programming. In particular, the following topics will be presented: Arithmetic, Matrices, Operators, Control flow, M-files, Graphics
Delivery modes	Lecture, seminar, individual and group work
Language	English
Recommended prerequisites	None
Student workload	Lecture (2 SWS): 30 h Discussion (2 SWS): 30 h Self-study: 120 h Total: 180 h
Study requirements	None
Requirement for admission to exam	None
Exam requirements	Written exam (90 – 150 min.) or alternatively oral exam (20 - 30 min). The type of the exam will be chosen by the instructor.
Module coordinator	Dr. Stefan Kopecz
Instructors	All instructors of the department
Media	Lab, Board, projector, Moodle, notes, assignments