Fall Term Course Contents

MATH 501 Algebra I (3-0-3)

Groups, cyclic groups, finite groups, alternating groups, quotient groups, isomorphism theorems, direct products of groups, free groups, free abelian groups, finitely generated abelian groups, Sylow theorems. Rings, ring homomorphisms, ideals, quotient rings, factorization in commutative rings, principle ideal domains, Euclidean domains, unique factorization domains, polynomial rings, factorization in polynomial rings, power series.

MATH 503 Advanced Linear Algebra (3-0-3)

Vector spaces, linear transformations, isomorphism theorems, modules, linear operators, eigenvalues and eigenvectors, real and complex inner product spaces, normal operators, metric vector spaces.

MATH 505 Real Analysis (3-0-3)

Set theory and real numbers, general measure and integration theory. Lebesgue measurable sets, measurable functions, convergence theorems, Radon-Nikodym theorem, outer measure, Carathe-odory extension theorem, product measures, Riesz representation, Baire Category, Banach Spaces.

MATH 507 General Topology (3-0-3)

Topological spaces and continuous functions, subspace topology, product topology, quotient topology, connectedness and compactness, countability and separation properties, Urysohn's lemma, The Tychonoff Theorem, metrization theorems and paracompactness.

MATH 509 Functional Analysis I (3-0-3)

Metric Spaces, Normed spaces, Banach spaces. Linear operators, Spaces of bounded linear operators. The uniform boundedness principle and the open mapping theorem, Bounded linear functionals. Dual spaces. The Hahn-Banach extension theorem. Separation of convex sets.

MATH 515 Differential Equations I (3-0-3)

Existence and Uniqueness for the solution of Initial Value Problems, Continuation of Solutions, Picard Successive Approximation Method, Systems of Differential Equations, Properties of System Solutions, Systems with Constant and Periodic Coefficients; Higher Order Linear Differential Equations, Autonomous Systems , Systems of Nonlinear Equations.

MATH 517 Coding Theory and Cryptology (3-0-3)

Basic concepts and codes, linear codes, some good codes, bounds on codes, perfect codes, cyclic codes, Goppa codes, cryptology, stream ciphers, cryptosytems.

MATH 519 Basic Algorithms and Programming (3-0-3)

Fundamentals of Programming, Introduction to MATLAB and programming with MATLAB, Basic Algorithms and problem solving in Linear Algebra and Differential Equations, introducing LATEX, typesetting text using LATEX packages, constructing tables, bibliography and mathematical formulae, graphing.

MATH 521 Introduction to Scientific Computing I (3-0-3)

Introduction, Error Analysis, Numerical Solution of Equations of One Variable, Direct Methods for Solving Linear Systems, Iterative Techniques for Solving Linear Systems, Approximating Eigenvalues, Numerical Solutions of Systems of Nonlinear Equations.

MATH 523 Partial Differential Equations I (3-0-3)

Introduction to Partial Differential Equations Theory, Important Linear Partial Differential Equations: Transport Equation, Laplace Equation, Heat Equation, Wave Equation ; Nonlinear First Order Partial Differential Equations, Separation of Variables, Transform Methods (Fourier Transform, Laplace Transform)

MATH 525 Methods of Applied Mathematics (3-0-3)

Calculus of Variations, Euler-Lagrange Equations, Various applications including isoperimetric problems and computer vision, Basics of PDEs, Derivation of basic PDEs via vectorial approaches, Derivation of basic PDEs via variational principle, Separation of variables & boundary conditions, Importance of the boundary conditions, Basics of Fourier Series, Sturm-Liouville Problems, Green's Functions, Eigenfunction Expansion, Linear Integral Equations.

MATH 527 Dynamical Systems (3-0-3)

Linear dynamical systems, Solutions of nonlinear dynamical systems, Linearization methods for nonlinear dynamical systems, Lagrangian and Hamiltonian systems, Global theory of nonlinear dynamical systems, Bifurcation theory for nonlinear dynamical systems.

MATH 529 Numerical Solutions for Ordinary Differential Equations (3-0-3)

Introduction to Numerical Methods, The Elementary Theory of Initial Value Problems, Taylor Methods, Runge-Kutta Methods, Error Control and Runge-Kutta-Fehlberg Method, Multi-Step Methods, Numerical Solution of Higher Order Equations and Systems of Equations, Numerical Solution of Boundary Value Problems for Ordinary Differential Equations, Finite Difference Methods for Nonlinear Problems, Stability.

MATH 531 Topics in Applied Mathematics I (3-0-3)

Introduction to ordinary differential equations, linear first order ODEs, integrating factors, integral curves, singular points, series solution, convergence, existence and uniqueness, the view in the complex plane, nonlinear first order ODEs, Picard's existence and uniqueness theorem, second order linear IVPs, reduction of order, variation of parameters, the Laplace transform, convolution, initial value problems with discontinuous and impulsive forcing functions, inverting Laplace transforms with the Mellin inversion formula and the Bromwich contour, higher order linear IVPs, conversion to first order systems, the fundamental matrix, eigenvalues, eigenvectors and generalized eigenvectors, decoupling systems via similarity transformations, phase plane interpretations, nonlinear first order ODEs.

MATH 533 Combinatorics (3-0-3)

Generating functions, recurrence relations, extremal problems for graphs and set systems, probabilistic methods in combinatorics, algebraic methods in combinatorics.

MATH 800 Special Studies (8-0-2)

MATH 810 Seminar (0-10-0)

MATH 820 Master's Thesis (0-30-0)

Spring Term Course Contents

MATH 502 Algebra II (3-0-3) Modules, projective and injective modules, free modules, vector spaces, tensor products, modules over a PID. Fields, field extensions, algebraic extensions, Galois theory, splitting fields, algebraic closure. Finite fields.
MATH 504 Complex Analysis (3-0-3) Complex numbers, differentiation, integraion, Cauchy's theorem, harmonic fuctions, Taylor and Laurent series, isolated singularities and the residue theorem, applications of the residue theorem.
MATH 506 Differential Geometry (3-0-3) Curves and surfaces, plane curves, geometry of hypersurfaces, lengths and distances, curvature, Riemannian connection, geodesics, normal coordinates, conjugate points, isometric immersions, Metric and geodesic completeness, variations of the energy functional.
MATH 508 Numerical Linear Algebra (3-0-3) Introduction. Summary/recap of basic concepts from linear algebra and numerical analysis: matrices, operation counts. Matrix factorizations. (Cholesky factorization. QR factorization, LU factorization and Gaussian elimination; partial pivoting), Linear systems, Sparse and banded linear systems and iterative methods, Linear least squares problem, Singular value decomposition (SVD), Eigenvalue problem.
MATH 510 Functional Analysis II (3-0-3) Spaces of continuous functions, Ascoli's theorem, Stone-Weierstrass' theorem, Spaces of Holder continuous functions and of k-times differentiable functions, Hilbert spaces, Compact operators on a Hilbert space. Fredholm's alternative. Spectrum and eigenfunctions of a compact, self-adjoint operatör, Weak derivatives, Sobolev spaces, Embedding theorems.
MATH 516 Differential Equations II (3-0-3) Nonlinear Periodic Systems, Bifurcation, Boundary Value Problems, Linear Differential Operators, Boundary Conditions, Existence of Solutions of Boundary Value Problems, Eigenvalues and Eigenfunctions for Linear Differential Operators, Green's Function of a Linear Differential Operator.
MATH 518 Finite Fields and Their Applications (3-0-3) Structure of finite fields, polynomials over finite fields, factorization of polynomials, applications of finite fields.
MATH 520 Integral Equations (3-0-3) Basics of Integral equations, types of integral equations, Volterra and Fredholm integral equations, degenerate kernels, Green's functions, Fredholm Alternative.
MATH 522 Introduction to Scientific Computing II (3-0-3) Finite Differences, Interpolation ve Polynomial Approximation, Numerical Differentiation and Integration, Approximation Theory.

MATH 524 Partial Differential Equations II (3-0-3)

Sobolev Spaces, Weak Derivatives, Second Order Elliptic and Parabolic Equations and their Weak Solutions, Regularity of Solutions, Energy Estimates, Maximum Principles, Second Order Hyperbolic Equations.

MATH 526 Special Functions (3-0-3)

Preliminaries, The Gamma Function, The Beta function, Bessel functions, Legendre polynomials, Hermite and Laguere polynomials, Chebyshev and Jacobi polynomials, Hypergeometric functions, Applications of Special functions.

MATH 528 Mathematical Modelling (3-0-3)

The Modelling Process, Discrete Models, Difference Equations, Continuous Models, Ordinary Differential Equations Models, Partial Differential Equations Models.

MATH 530 Numerical Solutions for Partial Differential Equations (3-0-3)

Introduction to the Elementary Theory of Partial Differential Equations, Well Posedness for Partial Differential Equations, Finite Difference Method for Elliptic and Parabolic Equations, Iterative Methods , Finite Difference Discretization of Hyperbolic Equations, Systems of Partial Differential Equations and Their Numerical Solutions.

MATH 532 Topics in Applied Mathematics II (3-0-3)

Linear stability analysis, Poincare-Bendixson theorem, linear equations with analytic coefficients, series solutions near ordinary points, solution behavior near singular points, regular singular points, Euler equations, solutions near regular singular points by the method of Frobenius, asymptotics and WKBJ solutions, separation of variables for partial differential equations, boundary value problems, Gibb's phenomenon, Fourier transforms, Bessel functions and other special functions, Green's functions, eigenvalue problems, eigenfunction expansions, Sturm-Liouville theory.

MATH 534 Probability Theory (3-0-3)

Probability distributions, random variables, expectation, convergence of distribution, connection between probability theory and real analysis, weak and strong laws of large numbers, central limit theorem.

MATH 536 Graph Theory (3-0-3)

Types of graphs, matching, connectivity, planar graphs, coloring of graphs, Ramsey theory.

MATH 800 Special Studies (8-0-2)

MATH 810 Seminar (0-10-0)

MATH 820 Master's Thesis (0-30-0)