

MATHEMATICAL SCIENCES

OVERVIEW

The Department of Mathematics and Statistics offers programs towards the Doctor of Philosophy in Mathematical Sciences (the Ph.D. degree under the program heading of MASC). Students are encouraged to take courses in both core mathematics and applied mathematics, thereby gaining an appreciation of the connections between theory and applications.

Opportunities for research arise from the research interests of the Department faculty, which include analysis, algebra, biomathematics, combinatorics, complex systems, differential equations, fluid mechanics, graph theory, mathematics education, modeling, and number theory.

DEGREES

- Mathematical Sciences Ph.D.

FACULTY

Ashikaga, Takamaru; Professor, Department of Mathematics and Statistics; PHD, University of California Los Angeles

Bagrow, James; Assistant Professor, Department of Mathematics & Statistics; PHD, Clarkson University, Potsdam, NY

Bentil, Daniel E.; Associate Professor, Department of Mathematics and Statistics; DPHIL, University of Oxford

Bunn, Janice Yanushka; Research Associate Professor, Department of Mathematics and Statistics; PHD, Ohio State University

Buzas, Jeff Sandor; Professor, Department of Mathematics and Statistics; PHD, North Carolina State University Raleigh

Callas, Peter W.; Research Associate Professor, Department of Mathematics and Statistics; PHD, University of Massachusetts Amherst

Cole, Bernard F.; Professor, Department of Mathematics and Statistics; PHD, Boston University

Danforth, Christopher M.; Associate Professor, Department of Mathematics and Statistics; PHD, University of Maryland College Park

Dinitz, Jeffrey Howard; Professor, Department of Mathematics and Statistics; PHD, Ohio State University

Dodds, Peter S.; Professor, Department of Mathematics and Statistics; PHD, Massachusetts Institute of Technology

Foote, Richard Martin; Professor, Department of Mathematics and Statistics; PHD, University of Cambridge

Jefferys, William; Lecturer I, Department of Mathematics and Statistics; PHD, Yale University

Lakoba, Taras Igorevich; Associate Professor, Department of Mathematics and Statistics; PHD, Clarkson University

Mickey, Ruth Mary; Professor, Department of Mathematics and Statistics; PHD, University of California Los Angeles

Sands, Jonathan Winslow; Professor, Department of Mathematics and Statistics; PHD, University of California San Diego

Single, Richard M.; Associate Professor, Department of Mathematics and Statistics; PHD, SUNY Stony Brook

Son, Mun Shig; Professor, Department of Mathematics and Statistics; PHD, Oklahoma State University

Warrington, Gregory S.; Assistant Professor, Department of Mathematics and Statistics; PHD, Harvard University

Wilson, James Michael; Professor, Department of Mathematics and Statistics; PHD, University of California Los Angeles

Yang, Jianke; Professor, Department of Mathematics and Statistics; PHD, Massachusetts Institute of Technology

Yu, Jun; Professor, Department of Mathematics and Statistics; PHD, University of Washington Seattle

Courses

MATH 207. Probability Theory. 3 Credits.

Distributions of random variables and functions of random variables. Expectations, stochastic independence, sampling and limiting distributions (central limit theorems). Concepts of random number generation. Prerequisites: MATH 121; STAT 151 or STAT 153 recommended. Cross-listed with: STAT 251, BIOS 251.

MATH 221. Deterministic Modls Oper Rsch. 3 Credits.

The linear programming problem. Simplex algorithm, dual problem, sensitivity analysis, goal programming. Dynamic programming and network problems. Prerequisites: MATH 122 or MATH 124; MATH 121 desirable. Cross-listed with: CSYS 221.

MATH 222. Stochastic Models in Oper Rsch. 3 Credits.

Development and solution of some typical stochastic models. Markov chains, queueing problems, inventory models, and dynamic programming under uncertainty. Prerequisite: MATH 207, STAT 151.

MATH 230. Ordinary Differential Equation. 3 Credits.

Solutions of linear ordinary differential equations, the Laplace transformation, and series solutions of differential equations. Prerequisite: MATH 121. Corequisite: MATH 122 or MATH 124. Credit not granted for more than one of the courses MATH 230 or MATH 271.

MATH 235. Mathematical Models & Analysis. 3 Credits.

Techniques of Undergraduate calculus and linear algebra are applied for mathematical analysis of models of natural and human-created phenomena. Students are coached to give presentations. Prerequisites: MATH 121; MATH 122 or MATH 124 or MATH 230 or MATH 271.

MATH 236. Calculus of Variations. 3 Credits.

Necessary conditions of Euler, Legendre, Weierstrass, and Jacobi for minimizing integrals. Sufficiency proofs. Variation and eigenvalue problems. Hamilton-Jacobi equations. Prerequisite: MATH 230.

MATH 237. Intro to Numerical Analysis. 3 Credits.

Error analysis, root-finding, interpolation, least squares, quadrature, linear equations, numerical solution of ordinary differential equations. Prerequisites: MATH 121; MATH 122, MATH 124 or MATH 271; knowledge of computer programming.

MATH 238. Applied Computational Methods. 3 Credits.

Direct and iterative methods for solving linear systems; numerical solution of ordinary and partial differential equations. Focus will be on application of numerical methods. Prerequisites: MATH 121; MATH 122 or MATH 124 or MATH 271.

MATH 240. Fourier Series&Integral Trans. 3 Credits.

Fourier series, orthogonal functions, integral transforms and boundary value problems. Prerequisite: MATH 230 or MATH 271.

MATH 241. Anyl in Several Real Vars I. 3 Credits.

Properties of the real numbers, basic topology of metric spaces, infinite sequences and series, continuity. Prerequisites: MATH 052; MATH 121; MATH 122 or MATH 124.

MATH 242. Anyl Several Real Variables II. 3 Credits.

Differentiation and integration in n-space, uniform convergence of functions, fundamental theorem of calculus, inverse and implicit function theorems. Prerequisite: MATH 241.

MATH 251. Abstract Algebra I. 3 Credits.

Basic theory of groups, rings, fields, homomorphisms, and isomorphisms. Prerequisite: MATH 052; MATH 122 or MATH 124.

MATH 252. Abstract Algebra II. 3 Credits.

Modules, vector spaces, linear transformations, rational and Jordan canonical forms. Finite fields, field extensions, and Galois theory leading to the insolvability of quintic equations. Prerequisite: MATH 251.

MATH 255. Elementary Number Theory. 3 Credits.

Divisibility, prime numbers, Diophantine equations, congruence of numbers, and methods of solving congruences. Prerequisite: MATH 052 or MATH 054.

MATH 257. Topics in Group Theory. 3 Credits.

Topics may include abstract group theory, representation theory, classical groups, Lie groups. Prerequisite: MATH 251.

MATH 260. Foundations of Geometry. 3 Credits.

Geometry as an axiomatic science; various non-Euclidean geometries; relationships existing between Euclidean plane geometry and other geometries; invariant properties. Prerequisite: MATH 022 and either MATH 052 or MATH 054.

MATH 264. Vector Analysis. 3 Credits.

Gradient, curl and divergence, Green, Gauss, and Stokes Theorems, applications to physics, tensor analysis. PrerequisiteS: MATH 121; MATH 122 or MATH 124 or MATH 271.

MATH 266. Chaos,Fractals&Dynamical Syst. 3 Credits.

Discrete and continuous dynamical systems, Julia sets, the Mandelbrot set, period doubling, renormalization, Henon map, phase plane analysis and Lorenz equations. Co-requisite: MATH 271 or MATH 230. Cross-listed with: CSYS 266.

MATH 268. Mathematical Biology&Ecology. 3 Credits.

Mathematical modeling in the life sciences. Topics include population modeling, dynamics of infectious diseases, reaction kinetics, wave phenomena in biology, and biological pattern formation. Prerequisite: MATH 122 or MATH 124; MATH 230; or Instructor permission. Cross-listed with: CSYS 268.

MATH 271. Adv Engineering Mathematics. 3 Credits.

Differential equations and linear algebra, including linear ordinary differential equations, Laplace transforms, matrix theory, and systems of differential equations. Examples from engineering and physical sciences. Prerequisite: MATH 121. Credit not granted for both MATH 230 and MATH 271. No credit for Mathematics majors.

MATH 272. Applied Analysis. 3 Credits.

Basics of Fourier series, partial differential equations of mathematical physics, functions of a complex variable, Cauchy's theorem, integral formula. Prerequisites: MATH 230 or MATH 271.

MATH 273. Combinatorial Graph Theory. 3 Credits.

Paths and trees, connectivity, Eulerian and Hamiltonian cycles, matchings, edge and vertex colorings, planar graphs, Euler's formula and the Four Color Theorem, networks. Prerequisite: MATH 052 or MATH 054.

MATH 274. Numerical Linear Algebra. 3 Credits.

Direct and iterative methods for solving linear equations, least square factorization methods, eigenvalue computations, ill-conditioning and stability. Prerequisite: MATH 237.

MATH 295. Special Topics. 1-18 Credits.

For advanced students in the indicated fields. Lectures, reports, and directed readings on advanced topics. Credit as arranged. Offered as occasion warrants.

MATH 300. Principles of Complex Systems. 3 Credits.

Introduction to fundamental concepts of complex systems. Topics include: emergence, scaling phenomena, and mechanisms, multi-scale systems, failure, robustness, collective social phenomena, complex networks. Students from all disciplines welcomed. Pre/co-requisites: Calculus and statistics required; Linear Algebra, Differential Equations, and Computer programming recommended but not required. Cross-listed with: CSYS 300.

MATH 303. Complex Networks. 3 Credits.

Detailed exploration of distribution, transportation, small-world, scale-free, social, biological, organizational networks; generative mechanisms; measurement and statistics of network properties; network dynamics; contagion processes. Students from all disciplines welcomed. Pre/co-requisites: MATH 300/CSYS 300, Calculus, and Statistics required. Cross-listed with: CSYS 303.

MATH 330. Adv Ordinary Diff Equations. 3 Credits.

Linear and nonlinear systems, approximate solutions, existence, uniqueness, dependence on initial conditions, stability, asymptotic behavior, singularities, self-adjoint problems. Prerequisite: MATH 230.

MATH 331. Theory of Func of Complex Var. 4 Credits.

Differentiation, integration, Cauchy-Riemann equations, infinite series, properties of analytic continuation, Laurent series, calculus of residues, contour integration, meromorphic functions, conformal mappings, Riemann surfaces. Prerequisite: MATH 242.

MATH 332. Approximation Theory. 3 Credits.

Interpolation and approximation by interpolation, uniform approximation in normed linear spaces, spline functions, orthogonal polynomials. Least square, and Chebychev approximations, rational functions. Prerequisites: MATH 122 or MATH 124; MATH 237.

MATH 333. Thry Functions Real Variables. 4 Credits.

The theory of Lebesgue integration, Lebesgue measure, sequences of functions, absolute continuity, properties of LP-spaces. Prerequisite: MATH 242.

MATH 335. Advanced Real Analysis. 3 Credits.

L₂-spaces, LP-spaces; Hilbert, Banach spaces; linear functionals, linear operators; completely continuous operators (including symmetric); Fredholm alternative; Hilbert-Schmidt theory; unitary operators; Bochner's Theorem; Fourier-Plancherel, Watson transforms. Prerequisites: MATH 333.

MATH 336. Advanced Real Analysis. 3 Credits.

L₂-spaces, LP-spaces; Hilbert, Banach spaces; linear functionals, linear operators; completely continuous operators (including symmetric); Fredholm alternative; Hilbert-Schmidt theory; unitary operators; Bochner's Theorem; Fourier-Plancherel, Watson transforms. Prerequisite: MATH 333 and MATH 335.

MATH 337. Numerical Diff Equations. 3 Credits.

Numerical solution and analysis of differential equations: initial-value and boundary-value problems; finite difference and finite element methods. Prerequisites: MATH 121; MATH 122 or MATH 124; MATH 230 or MATH 271 or MATH 237 recommended.

MATH 339. Partial Differential Equations. 3 Credits.

Classification of equations, linear equations, first order equations, second order elliptic, parabolic, and hyperbolic equations, uniqueness and existence of solutions. Prerequisite: MATH 230; MATH 242.

MATH 351. Topics in Algebra. 3 Credits.

Topics will vary each semester and may include algebraic number theory, algebraic geometry, and the arithmetic of elliptic curves. Repeatable for credit with Instructor permission. Prerequisite: MATH 252.

MATH 353. Point-Set Topology. 3 Credits.

Topological spaces, closed and open sets, closure operators, separation axioms, continuity, connectedness, compactness, metrization, uniform spaces. Prerequisite: MATH 241.

MATH 354. Algebraic Topology. 3 Credits.

Homotopy, Seifert-van Kampen Theorem; simplicial, singular, and Cech homology. Prerequisite: MATH 241 or MATH 353.

MATH 373. Topics in Combinatorics. 3 Credits.

Topics will vary each semester and may include combinatorial designs, coding theory, topological graph theory, cryptography. Prerequisite: MATH 251 or MATH 273.

MATH 382. Seminar. 1 Credit.

Topical discussions with assigned reading. Required of M.S. degree candidates.

MATH 391. Master's Thesis Research. 1-18 Credits.**MATH 395. Special Topics. 1-18 Credits.**

Subject will vary from year to year. May be repeated for credit.

MATH 491. Doctoral Dissertation Research. 1-18 Credits.