MATHEMATICAL SCIENCES

http://www.uvm.edu/cems/mathstat/ (http://www.uvm.edu/~cems/mathstat/)

OVERVIEW

The Department of Mathematics and Statistics offers programs towards the Master of Science, Master of Science for Teachers, and Doctor of Philosophy in Mathematical Sciences. Students are encouraged to take courses in both pure 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, geometry, biomathematics, combinatorics, complex systems, computational social science, differential equations, fluid mechanics, modeling, network science, and number theory.

The Department also offers Master of Science degrees in Biostatistics and Statistics.

DEGREES

- Mathematical Sciences AMP (http://catalogue.uvm.edu/graduate/mathsciences/mathematicalsciencesamp)
- Mathematical Sciences M.S. (http://catalogue.uvm.edu/graduate/mathsciences/mathematicalsciencesms)
- Mathematics M.S.T. (http://catalogue.uvm.edu/graduate/mathsciences/mathematicalsciencemst)
- Mathematical Sciences Ph.D. (http://catalogue.uvm.edu/graduate/mathsciences/mathematicalsciencesphd)

FACULTY

Backman, Spencer; Assistant Professor, Department of Mathematics and Statistics; PHD, Clarkson University
Bagrow, James; Assistant Professor, Department of Mathematics and Statistics; PHD, Georgia Institute of Technology
Bentil, Daniel E.; Associate Professor, Department of Mathematics and Statistics; DPHIL, University of Oxford
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, Chris; Associate Professor, Department of Mathematics and Statistics; PHD, University of Maryland College Park
Dupuy, Taylor; Assistant Professor, Department of Mathematics and Statistics; PHD, University of New Mexico
Jefferys, William; Adjunct Professor, Department of Mathematics and Statistics; PHD, Yale University
Lakoba, Taras Igorevich; Associate Professor, Department of Mathematics and Statistics; PHD, Clarkson University

Rombach, Puck; Assistant Professor, Department of Mathematics and Statistics; PHD, University of Oxford, Somerville College
Single, Richard M.; Associate Professor, Department of Mathematics and Statistics; PHD, SUNY Stony Brook
Vincent, Christelle; Assistant Professor, Department of Mathematics and Statistics; PHD, Harvard University
Warrington, Gregory S.; Assistant Professor, Department of Mathematics and Statistics; PHD, University of Wisconsin-Madison
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 230. QR: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. QR: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 237. QR: 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 or MATH 124 or MATH 271; CS 020 or CS 021. Cross-listed with: CS 237.

MATH 240. QR: Fourier Series & Intgrl Trans. 3 Credits.
Fourier series, orthogonal functions, integral transforms and boundary value problems. Prerequisite: MATH 230 or MATH 271.

MATH 241. QR: 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 141 or MATH 151 or C- or better in Math 052; MATH 121; MATH 122 or MATH 124.

MATH 242. QR: Anyl Several Real Vars 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 247. QR: Complex Analysis. 3 Credits.
An introduction to the theory of analytic functions of one complex variable, covering the techniques of complex analysis useful in science and engineering as well as the theory. Topics include complex numbers, analytic and holomorphic functions, power and Laurent series expansions, and Cauchy’s theorems on integration. Prerequisites: MATH 052 or CS 064; MATH 121.
MATH 251. QR: Abstract Algebra I. 3 Credits.
Basic theory of groups, rings, fields, homomorphisms, and isomorphisms. Prerequisites: MATH 141 or MATH 151 or C- or better in MATH 052; MATH 122 or MATH 124.

MATH 252. QR: 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 insolubility of quintic equations. Prerequisite: MATH 251.

MATH 254. QR: Topology. 3 Credits.
An introduction to point set topology. Topics include open and closed sets, continuous functions, compactness, connectedness, metric and Hausdorff spaces. If time permits, introduction to algebraic topology through topics such as the fundamental group. Provides background for analysis and graduate topology courses as well as for topological data science. Prerequisites: MATH 052 or CS 064; MATH 121 or MATH 122 or MATH 124.

MATH 255. QR: Elementary Number Theory. 3 Credits.
Divisibility, prime numbers, Diophantine equations, congruence of numbers, and methods of solving congruences. A significant portion of the course devoted to individual and/or team projects. Prerequisite: MATH 052; MATH 121 or MATH 122 or MATH 124.

MATH 259. QR: Cryptography. 3 Credits.
A survey of classical and modern cryptography. The strengths and weaknesses of various cryptosystems are discussed. Topics include specific public-key and private-key cryptosystems such as RSA, ElGamal, and elliptic curve cryptosystems, as well as digital signatures and key exchange. Prerequisite: MATH 052 or CS 064; MATH 121 or MATH 122 or MATH 124.

MATH 260. QR: 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 MATH 052.

MATH 266. QR: 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. Prerequisite: MATH 122 or MATH 124. CS 020 or CS 021 recommended. Cross-listed with: CSYS 266.

MATH 268. QR: Mathematical Biology & Ecol. 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 MATH 271; or Instructor permission.

MATH 271. QR: Adv Engineering Mathematics. 3 Credits.
Differential equations, Laplace transforms, and systems of differential equations; brief introduction to Fourier series. Examples from engineering and physical sciences. Credit not granted for both MATH 230 and MATH 271. No credit for Mathematics majors. Prerequisite: MATH 121. Co-requisites: Preferred: MATH 122 or MATH 124; or MATH 120.

MATH 273. QR: 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.

MATH 300. Principles of Complex Systems. 3 Credits.
Introduction to fundamental concepts of complex systems. Topics include: emergence, scaling phenomena, and mechanisms, multiscale 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. 3 Credits.
Complex functions, differentiation and the Cauchy-Riemann equations, power and Laurent series, integration, calculus of residues, contour integration, isolated singularities, conformal mapping, harmonic functions. Prerequisite: MATH 242.

MATH 333. Thry Functions Real Variables. 3 Credits.
Lebesgue measure and integration theory, Monotone and Dominated Convergence Theorems and applications, product measures, basic theory of LP-spaces. Prerequisite: MATH 242.

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 349. Nonlinear Partial Diff Eqs. 3 Credits.
This course covers modern mathematical theories and numerical methods for nonlinear partial differential equations. Topics include: inverse scattering transform; solitons; bilinear method; Darboux transformation; solitary waves; Vakhitov-Kolokolov stability criterion; transverse instability; virial theorem; wave collapse; pseudo-spectral method; split-step method. Prerequisites: MATH 330 (or equivalent) or Instructor permission.

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.

MATH 391. Master's Thesis Research. 1-18 Credits.

MATH 392. Independent Study. 1-18 Credits.
A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

MATH 395. Advanced 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.

MATH 496. Advanced Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.