MATHEMATICAL SCIENCES

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. The Ph.D. program has three areas of concentration: Pure Mathematics, Applied Mathematics, and Statistics. The Department also offers M.S. degrees in Statistics and in Biostatistics and M.S. and Ph.D. degrees in Complex Systems & Data Science. It has Accelerated Master's Programs in Mathematics and in Statistics, which are available to UVM undergraduate students.

Opportunities for research arise from the research interests of the Department faculty, which include: algebraic geometry, algebraic and computational topology, arithmetic geometry, combinatorics/ graph theory, complex systems, computational social science, logic, mathematical cryptography, network science, number theory, topological data analysis, fluid mechanics, numerical methods for, and analytical theories of, partial differential equations, as well as bioinformatics, time series analysis, survival analysis, discriminant analysis, classification methods, bootstrap methods, categorical data analysis, measurement error models, and experimental design.

DEGREES

Mathematical Sciences AMP

Mathematical Sciences M.S.

Mathematics M.S.T.

Mathematical Sciences Ph.D.

FACULTY

Backman, Spencer; Assistant Professor, Department of Mathematics and Statistics, PHD, Georgia Institute of Technology
Bagrow, James; Associate Professor, Department of Mathematics and Statistics; PHD, Clarkson University
Buzas, Jeff Sandor; Professor, Department of Mathematics and Statistics; PHD, North Carolina State University Raleigh
Cole, Bernard F.; Professor, Department of Mathematics and Statistics; PHD, Boston University
Crocker, Abigail; Associate Professor, Department of Mathematics and Statistics; PHD, University of Vermont
Danforth, Chris; 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
Edwards, Erika; Research Associate Professor, Department of Mathematics and Statistics; PHD, Boston University School of Public Health
Eismeier, Mike Miller; Assistant Professor, Department of Mathematics and Statistics; PHD, University of California, Los Angeles
Lakoba, Taras Igorevich; Professor, Department of Mathematics and Statistics; PHD, Clarkson University
Martin, Jacob; Senior Lecturer, Department of Mathematics and Statistics; PHD, University of Georgia
Patania, Alice; Assistant Professor, Department of Mathematics and Statistics; PHD, Politecnico di Torino
Rombach, Puck; Associate 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
Tivnan, Brian; Adjunct Assistant Professor, Department of Mathematics and Statistics; EDD, George Washington University
Vincent, Christelle; Associate Professor, Department of Mathematics and Statistics; PHD, University of Wisconsin-Madison
Warrington, Gregory S.; 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
Young, Jean-Gabriel; Assistant Professor, Department of Mathematics and Statistics; PHD, Université Laval
Yu, Jun; Professor, Department of Mathematics and Statistics; PHD, University of Washington Seattle

Mathematics Courses

MATH 5230. 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: Graduate student or Instructor permission; knowledge of differential equations required.

MATH 5678. 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: Graduate student or Instructor permission.

MATH 5737. Gr Intro to Numerical Anyl. 3 Credits.
Error analysis, root-finding, interpolation, least squares, quadrature, linear equations, numerical solution of ordinary differential equations. Credit not awarded for both MATH 5737 and MATH 3737 or CS 3737. Prerequisite: Graduate student or Instructor permission. Cross-listed with: CS 5737.

MATH 5766. Gr Chaos,Fractals&Dynmcl Systm. 3 Credits.
Discrete and continuous dynamical systems, Julia sets, the Mandelbrot set, period doubling, renormalization, Henon map, phase plane analysis and Lorenz equations. Credit not awarded for both MATH 5766 and MATH 3766. Prerequisites: Graduate student or Instructor permission. Cross-listed with: CSYS 5766.

MATH 5788. 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. Prerequisites: Graduate student or Instructor permission; knowledge of linear algebra and differential equations required.

MATH 5990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

MATH 5993. 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 6230. 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: Knowledge of differential equations required.

MATH 6344. Algebraic Topology. 3 Credits.
Homotopy, Seifert-van Kampen Theorem; simplicial, singular, and Cech homology. Prerequisite: Knowledge of real analysis or topology required.

MATH 6391. Master's Thesis Research. 1-18 Credits.
Research for the Master's Thesis.

MATH 6441. 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: Two semesters of real analysis required.

MATH 6444. 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: Two semesters of real analysis required.

MATH 6551. Abstract Algebra III. 3 Credits.
Advanced group theory and field theory. Prerequisite: Two semesters of abstract algebra required.

MATH 6555. Abstract Algebra IV. 3 Credits.
Ring theory and module theory at the graduate level, with emphasis on commutative algebra. Prerequisite: MATH 6551.

MATH 6678. Topics in Combinatorics. 3 Credits.
Topics will vary each semester and may include combinatorial designs, coding theory, topological graph theory, cryptography. Course is repeatable for credit. Prerequisite: MATH 3551 or MATH 5678.

MATH 6701. Principles of Complex Systms 1. 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 6701.

MATH 6713. Principles of Complex Systms 2. 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 6701, CSYS 6701, calculus, and statistics required. Cross-listed with: CSYS 6713.

MATH 6737. 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: Calculus and linear algebra required in addition to differential equations or numerical analysis.

MATH 6990. Special Topics. 1-18 Credits.
Subject will vary from year to year. May be repeated for credit.

MATH 6991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

MATH 6993. 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 6995. Graduate Independent Research. 1-18 Credits.
Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

MATH 7491. Doctoral Dissertation Research. 1-18 Credits.
Research for the Doctoral Dissertation.

MATH 7990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

MATH 7991. Internship. 1-18 Credits.
On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

MATH 7995. Graduate Independent Research. 1-18 Credits.
Graduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

Statistics Courses

STAT 5000. Biostatistics and Epidemiology. 3 Credits.
Introductory design and analysis of medical studies. Epidemiological concepts, case-control and cohort studies. Clinical trials. Students evaluate statistical aspects of published health science studies. Understand the relevance of published public health research to clinical practice. Credit not awarded for both STAT 5000 and STAT 3000. Prerequisite: Graduate student or Instructor permission.

STAT 5020. Applied Statistics I. 3 Credits.
Foundational statistics, conducting data analysis using statistical software, collaborating as part of an interdisciplinary team, and communicating and presenting research findings. Practical issues and meaningful, real-world impacts of data projects with an emphasis on data equity, data processing, visualization, basic statistical procedures and concepts, and interpretation and communication of results. Focuses on the responsible application of basic statistical methods, concentrating on concepts rather than mathematical theory. Background in calculus or linear algebra is not required. Prerequisites: Graduate student or Instructor permission.

STAT 5210. Advanced Stat Methods & Theory. 3 Credits.
Parametric and non-parametric two-sample tests. Multiple regression and correlation. Matrix representations. Basic experimental design. Analysis of variance (fixed, random, and mixed models). Statistical Software usage. Credit not awarded for both STAT 5210 and STAT 3210. Prerequisites: Graduate student or Instructor permission; content knowledge of STAT 2830 assumed.

STAT 5230. Appld Multivariate Analysis. 3 Credits.
Multivariate normal distribution. Inference for mean vectors and covariance matrices. Multivariate analysis of variance (MANOVA), discrimination and classification, principal components, factor and cluster analysis. Prerequisite: STAT 3210, matrix algebra recommended.

STAT 5290. Survivl/Logistic Regression. 3 Credits.
Models and inference for time-to-event and binary data. Censored data, life tables, Kaplan-Meier estimation, logrank tests, proportional hazards models. Logistic regression-interpretation, assessment, model building, special topics. Prerequisite: Graduate student or Instructor permission; content knowledge of STAT 3210 or STAT 5210 assumed.

STAT 5310. Experimental Design. 3 Credits.
Randomization, complete and incomplete blocks, cross-overs, Latin squares, covariance analysis, factorial experiments, confounding, fractional factorials, nesting, split plots, repeated measures, mixed models, response surface optimization. Prerequisites: Graduate student or Instructor permission; content knowledge of STAT 3210 or STAT 5210 assumed; content knowledge of STAT 5010 recommended.

STAT 5350. Categorical Data Analysis. 3 Credits.
Measures of association and inference for categorical and ordinal data in multiway contingency tables. Log linear and logistic regression models. Prerequisite: Graduate student or Instructor permission; content knowledge of STAT 3210 or STAT 5210 assumed.

STAT 5510. 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: Graduate student or Instructor permission; content knowledge of MATH 2248, STAT 2510 assumed.

STAT 5530. Appl Time Series&Forecastng. 3 Credits.
Autoregressive moving average (Box-Jenkins) models, autocorrelation, partial correlation, differencing for nonstationarity, computer modeling. Forecasting, seasonal or cyclic variation, transfer function and intervention analysis, spectral analysis.

STAT 5870. Data Science I - Experience. 3 Credits.
Data harvesting, cleaning, and summarizing; working with non-traditional, non-numeric data (social network, natural language textual data, etc.); scientific visualization; advanced data pipelines with a practical focus on real datasets and developing good habits for rigorous and reproducible computational science; Project-based. Credit not awarded for both STAT 5870 and STAT 3870. Prerequisites: Knowledge of CS 1210 and either STAT 1410 or STAT 2430 required; knowledge of CS 2100 and MATH 2522 or MATH 2544 recommended; Graduate student or Instructor permission. Cross-listed with: CSYS 5870, CS 5870.

STAT 5990. Special Topics. 1-18 Credits.
See Schedule of Courses for specific titles.

STAT 6020. Applied Statistics II. 3 Credits.
Expands on foundational knowledge of statistics by teaching advanced methods and approaches, including conducting analyses using statistical software, collaborating as part of an interdisciplinary team, communicating and presenting research findings. Addresses practical issues and meaningful, real-world impacts with an emphasis on data equity and interpretation and communication of results. Focuses on the responsible application of advanced statistical methods, concentrating on concepts rather than mathematical theory. Background in calculus or linear algebra is not required. Prerequisites: STAT 5020; Graduate student or Instructor permission.

STAT 6300. Bayesian Statistics. 3 Credits.
Introduction to Bayesian inference. Posterior inference, predictive distributions, prior distribution selection. MCMC algorithms. Hierarchical models. Model checking and selection. Use of computer software. Prerequisite: Content knowledge of STAT 5510 assumed.

STAT 6391. Master's Thesis Research. 1-18 Credits.
Research for the Master's Thesis.

STAT 6810. Statistical Research. 1-3 Credits.
Methodologic or data analytic research culminating in oral and written reports to the faculty. Prerequisite: Instructor permission.

STAT 6850. Consulting Practicum. 1-3 Credits.
Supervised field work in statistical consulting. Experiences may include advising UVM faculty and students or clients in applied settings such as industry and government agencies. Prerequisites: Second year Graduate student in Statistics or Biostatistics; permission of Statistics Program Director.

STAT 6870. Data Science II. 3 Credits.
Advanced data analysis, collection, and filtering; statistical modeling, monte carlo statistical methods, and in particular Bayesian data analysis, including necessary probabilistic background material; a practical focus on real datasets and developing good habits for rigorous and reproducible computational science. Prerequisites: STAT 5870, CS 5870, CSYS 5870, or Instructor permission. Cross-listed with: CS 6870, CSYS 6870.

STAT 6990. Special Topics. 1-18 Credits.
Lectures or directed readings on advanced and contemporary topics not presently included in other statistics courses. Prerequisites: As listed in schedule of courses.

STAT 6993. 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.

STAT 7980. Applied Geostatistics. 3 Credits.
Introduction to the theory of regionalized variables, geostatistics (kriging techniques): special topics in multivariate analysis; Applications to real data subject to spatial variation are emphasized. Prerequisites: Programming skills (such as in Python or Matlab) and content knowledge of multivariate statistics (such as STAT 5230) are assumed. Cross-listed with: CEE 7980, CSYS 7980.