MATHEMATICS

OVERVIEW

The Department of Mathematics and Statistics offers programs towards the Master of Science (the Mathematics M.S.degree), the Master of Science in Teaching (the Mathematics M.S.T. degree), and the Doctor of Philosophy (the Mathematical Sciences Ph.D. degree). The Department also offers Master of Science degrees in Statistics and Biostatistics, described under the headings of Statistics and Biostatistics in this catalog.

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.

Students in the M.S. and Ph.D. degree programs are encouraged to take courses in both core and applied mathematics, thereby gaining an appreciation of the connections between theory and applications.

The Department offers an Accelerated Master's Program (AMP) leading to a B.S. and an M.S. degree in five years. Interested students should contact the department by the beginning of their junior year.

The Department of Mathematics and Statistics is also home to the Vermont Mathematics Initiative (VMI), a mathematics content focused professional development program for K-12 teachers. Teachers accepted into the VMI program are eligible to apply to the Master of Science in Teaching (M.S.T.) degree program. VMI program requirements meet the requirements of the M.S.T. degree.

DEGREES

- Mathematics AMP
- Mathematics M.S.
- Mathematics M.S.T.

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
Ellis-Monaghan, Joanna; Adjunct Professor, Department of Mathematics & Statistics, PHD, University of North Carolina, Chapel Hill
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
Scarpino, Samuel V.; Assistant Professor, Department of Mathematics and Statistics; PHD, University of Texas at Austin
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

Mathematics for Educators Courses

MAED 205. Math as a Second Language. 3 Credits.
Deep conceptual understanding of the operations of arithmetic and interrelationships among arithmetic, algebra, and geometry; applications to the K-8 classroom. Prerequisite: Teacher license.

MAED 210. Functions/Algebra for Teaching. 3 Credits.
Functions, graphs, inverse functions, linear functions, straight lines, linear equations and inequalities, and applications; applications to the K-8 classroom. Prerequisite: MAED 205.

MAED 215. Trig/Algebra for Teachers II. 3 Credits.
Similar triangles, trigonometric functions, applications to measurement, periodic phenomena; quadratic functions; applications to the K-8 classroom. Prerequisites: MAED 205 and MAED 210.

MAED 220. Measure/Probabil for Teachers. 3 Credits.
Measurement (length, area and volume), probability, application to problem solving, and the ways in which these concepts develop across the K-12 curriculum. Prerequisites: MAED 205, MAED 210, and MAED 215.

MAED 225. Number Theory for Teachers. 3 Credits.
Division algorithm, prime numbers, fundamental theorem of arithmetic, factors and multiples, number bases, arithmetic progressions; emphasis on how number theory is taught in grades K-8. Prerequisites: MAED 205, MAED 210, and MAED 215.

MAED 230. Alg/Geom for Teachers III. 3 Credits.
Exponents, compound interest, exponential functions, logarithms, the base e, growth and decay, research in mathematics education and K-8 curriculum projects. Prerequisites: MAED 205, MAED 210, and MAED 215.

MAED 235. Calculus for Teachers I. 3 Credits.
Limits, instantaneous change, differentiation, optimization, applications to the K-8 classroom, and K-8 curriculum projects. Prerequisites: MAED 205, MAED 210, MAED 215, MAED 220, and MAED 230.

MAED 240. Calculus for Teachers II. 3 Credits.
Continued study of calculus and its relationship to the K-8 curriculum. Topics include infinite series, calculating area, the definite integral, Fundamental Theorem of Calculus. Prerequisite: MAED 235.

MAED 300. Statistics & Research I. 3 Credits.
Introduction to statistics with emphasis on research in K-8 education. Representing and summarizing data, measures of relationship between variables, inference from sample data to population. Prerequisites: MAED 205, MAED 210, and MAED 215.

MAED 305. Statistics & Research II. 3 Credits.
Error bars in graphs, margins of error in surveys, and confidence intervals; interpret and critique educational research studies; analysis of school assessment data activities. Prerequisite: MAED 300.

MAED 310. Statistics & Research III. 3 Credits.
Regression, chi-square analysis, design of research studies, reading of research on K-8 instructional practice, design action research project. Pre/co-requisites: MAED 305, or Prerequisite: MAED 305.

MAED 315. Capstone VMI Experience. 3 Credits.
This course concludes the VMI's school-based-research component. Teachers synthesize their coursework and field experiences and revisit key mathematical concepts from arithmetic through calculus. Prerequisite: 30 hours MAED courses.

Mathematics 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.

Statistics Courses

STAT 200. Med Biostatistics&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. Prerequisite: STAT 111, STAT 141, STAT 143, or STAT 211. Cross-listed with: BIOS 200.

STAT 201. Stat Computing & Data Analysis. 3 Credits.
Fundamental data processing, code development, graphing and analysis using statistical software packages, including SAS and R. Analysis of data and interpretation of results. Prerequisite: STAT 111 with Instructor permission, or STAT 141 or STAT 211.

STAT 211. Statistical Methods I. 3 Credits.
Fundamental concepts for data analysis and experimental design. Descriptive and inferential statistics, including classical and nonparametric methods, regression, correlation, and analysis of variance. Statistical software. Prerequisite: Junior standing. Cross-listed with: BIOS 211.

STAT 221. Statistical Methods II. 3 Credits.
Cross-listed with: BIOS 221. Multiple regression and correlation. Basic experimental design. Analysis of variance (fixed, random, and mixed models). Analysis of covariance. Computer software usage. Prerequisite: STAT 141, STAT 143, or STAT 211.

STAT 223. Applied 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: Any 200-level Statistics course, STAT 221 or STAT 225 recommended, matrix algebra recommended. Cross-listed with: BIOS 223.

STAT 224. Stats for Quality&Productivity. 3 Credits.
Statistical process control; Shewhart, cusum and other control charts; process capability studies. Total Quality Management. Acceptance, continuous, sequential sampling. Process design and improvement. Case studies. Prerequisite: STAT 141, STAT 143, or STAT 211.

STAT 225. Applied Regression Analysis. 3 Credits.
Simple linear and multiple regression models; least squares estimates, correlation, prediction, forecasting. Problems of multicollinearity and influential data (outliers).

STAT 229. Survival/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: STAT 221 or above. Cross-listed with: BIOS 229.

STAT 231. 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. Prerequisite: STAT 211; STAT 221 recommended.

STAT 233. Survey Sampling. 3 Credits.
Design and data analysis for sample surveys. Simple random, stratified, systematic, cluster, multistage sampling. Practical issues in planning and conducting surveys. Prerequisite: STAT 211; or STAT 141 or STAT 143 with Instructor permission.

STAT 235. 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: STAT 211. Cross-listed with: BIOS 235.

STAT 237. Nonparametric Statistical Mthd. 3 Credits.
Nonparametric and distribution free methods; categorical, ordinal, and quantitative data; confidence intervals; rank and chi-square hypothesis tests; computer-intensive procedures (bootstrap, exact tests). Prerequisite: STAT 211; or STAT 141 or STAT 143 with Instructor permission.

STAT 241. Statistical Inference. 3 Credits.
Introduction to statistical theory: related probability fundamentals, derivation of statistical principles, and methodology for parameter estimation and hypothesis testing. Prerequisites: STAT 151, STAT 153, or STAT 251, and STAT 141 or equivalent, and MATH 121. Cross-listed with: BIOS 241.

STAT 251. 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. Prerequisite: MATH 121; STAT 151 or STAT 153 recommended. Cross-listed with: MATH 207, BIOS 251.

STAT 252. Appl Discr Stochas Proc Models. 1 Credit.
Markov chain models for biological, social, and behavioral systems models. Random walks, transition and steady-state probabilities, passage and recurrence times. Prerequisite: STAT 151, STAT 153, or STAT 251.

STAT 253. Appl Time Series & Forecasting. 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. Prerequisite: STAT 211 or STAT 225; or STAT 141 or STAT 143 with Instructor permission. Cross-listed with: CSYS 253.

STAT 256. Neural Computation. 3 Credits.
Introduction to artificial neural networks, their computational capabilities and limitations, and the algorithms used to train them. Statistical capacity, convergence theorems, backpropagation, reinforcement learning, generalization. Prerequisites: MATH 122 or MATH 124 or MATH 271; STAT 143 or STAT 153 or equivalent; CS 110. Cross-listed with: CS 256, CSYS 256.

STAT 261. Statistical Theory. 3 Credits.
Point and interval estimation, hypothesis testing, and decision theory. Application of general statistical principles to areas such as nonparametric tests, sequential analysis, and linear models. Prerequisite: STAT 251; or STAT 151 or STAT 153 with Instructor permission. Cross-listed with: BIOS 261.

STAT 265. Integrated Product Development. 3 Credits.
Project-based course focusing on the entire product life cycle. Team dynamics, process and product design, quality, materials, management, and environmentally-conscious manufacturing. Prerequisite: Senior standing. Cross-listed with: BSAD 293.

STAT 281. Statistics Practicum. 1-3 Credits.
Intensive experience in carrying out a complete statistical analysis for a research project in substantive area with close consultation with a project investigator. Prerequisite: STAT 200 or STAT 201 or STAT 221 through STAT 237 or STAT 253; some statistical software experience; Instructor permission.

STAT 287. Data Science I. 3 Credits.
Data harvesting, cleaning, and summarizing. Working with non-traditional, non-numeric data (social network, natural language textual data, etc.). Scientific visualization using static and interactive "infographics". A practical focus on real datasets, and developing good habits for rigorous and reproducible computational science. Prerequisites: CS 020 or CS 021; STAT 141 or STAT 143 or STAT 211; CS 110 and MATH 124 recommended.

STAT 295. Advanced Special Topics. 1-18 Credits.
For advanced students. Lectures, reports, and directed readings on advanced topics. Prerequisite: As listed in schedule of courses.

STAT 308. Applied Biostatistics. 3 Credits.
The rationale and application of biostatistical methods in the biological, health and life sciences with emphasis on interpreting and reporting results. sciences. Prerequisite: STAT 141 or equivalent. Cross-listed with: MPBP 308, BIOS 308.

STAT 321. Seminar in Advanced Statistics. 1 Credit.
Seminar presentations and discussions of statistical literature pertaining to the theoretical aspects of methods studied in STAT 221, STAT 223, STAT 224, STAT 225, and STAT 229, respectively. Corequisites: STAT 221; STAT 241 or STAT 261 recommended.

STAT 323. Seminar in Advanced Statistics. 1 Credit.
Seminar presentations and discussions of statistical literature pertaining to the theoretical aspects of methods studied in STAT 221, STAT 223, STAT 224, STAT 225, and STAT 229, respectively. Co-requisites: STAT 223; STAT 241 or STAT 261 recommended.

STAT 324. Seminar in Advanced Statistics. 1 Credit.
Seminar presentations and discussions of statistical literature pertaining to the theoretical aspects of methods studied in STAT 221, STAT 223, STAT 224, STAT 225, and STAT 229, respectively Co-requisites: STAT 224; STAT 241 or STAT 261 recommended.

STAT 325. Seminar in Advanced Statistics. 1 Credit.
Seminar presentations and discussions of statistical literature pertaining to the theoretical aspects of methods studied in STAT 221, STAT 223, STAT 224, STAT 225, and STAT 229, respectively. Co-requisites: STAT 225 or STAT 221; STAT 241 or STAT 261 recommended.

STAT 329. Seminar in Advanced Statistics. 1 Credit.
Seminar presentations and discussions of statistical literature pertaining to the theoretical aspects of methods studied in STAT 221, STAT 223, STAT 224, STAT 225, and STAT 229, respectively. Co-requisite: STAT 229; STAT 241 or STAT 261 recommended.

STAT 330. 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. Pre/co-requisite: STAT 241 or STAT 251 or Instructor permission.

STAT 355. Statisticl Pattern Recognition. 3 Credits.
Analysis of algorithms used for feature selection, density estimation, and pattern classification, including Bayes classifiers, maximum likelihood, nearest neighbors, kernels, discriminants, neural networks and clustering. Prerequsite: STAT 241 or STAT 251, or Instructor permission. Cross-listed with: CS 355, CSYS 355.

STAT 360. Linear Models. 3 Credits.
Theory of linear models, least squares and maximum likelihood estimation, fixed, random and mixed models, variance component estimation, introduction to generalized linear models, bootstrapping. Prerequisites: STAT 261 and knowledge of matrix algebra or Instructor permission.

STAT 369. 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. Pre/co-requisites: STAT 223 or STAT 225, and CS 016 or CE 011 or permission. Cross-listed with: CSYS 369.

STAT 380. Sem:Statistics & Biostatistics. 0.5-1 Credits.
Presentation and discussion of current topics, methodological research and applications in Statistics and Biostatistics by graduate students, faculty and guest speakers. Prerequisite: Instructor Permission.

STAT 381. Statistical Research. 1-3 Credits.
Methodologic or data analytic research culminating in oral and written reports to the faculty. Prerequisite: Instructor permission. Cross-listed with: BIOS 381.

STAT 385. 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 standing in Statistics or Biostatistics and permission of Statistics Program Director.

STAT 387. 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. Prerequisite: STAT 287 or Instructor permission.

STAT 391. Master's Thesis Research. 1-6 Credits.

STAT 395. Advanced 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.