MATHEMATICS AND STATISTICS (MST/STA)

Mathematics and Statistics (MST/STA) Master of Science

Overview

The program is designed to accommodate students seeking either a terminal master's degree or preparation for PhD work.

To obtain the Master of Science degree in one year, a graduate student must present evidence of having completed the work required of an undergraduate who majors in mathematics in a fully accredited college or university. Such a major is understood to include at least 33 semester hours of mathematics, of which at least 18 require as prerequisite one year of calculus. Students who are admitted with less than the level of preparation specified should expect to take additional courses at the 600-level and remain in residence for more than one year.

Students desiring to use work taken in the department for graduate teacher certification should consult the Department of Education before applying for candidacy.

Students in the program have access to state-of-the-art equipment and facilities, including the DEAC Linux cluster (https://is.wfu.edu/services/high-performance-computing/).

Programs

- Mathematics and Statistics, MS (https://bulletin.wfu.edu/graduate/programs/degree-programs/mathematics-statistics/mathematics-statistics-ms/)
- Structural and Computational Biophysics (SCB), Certificate (https://bulletin.wfu.edu/graduate/programs/certificates/structural-computational-biophysics-scb-certificate/)

Courses

Mathematics MST

MST 605. Applied Multivariable Mathematics. (3 h)
Introduction to several topics in applied mathematics including complex numbers, probability, matrix algebra, multivariable calculus, and ordinary differential equations. May not be used toward any graduate degree offered by the department.

MST 606. Advanced Mathematics for the Physical Sciences. (3 h)
Advanced topics in linear algebra, special functions, integral transforms, and partial differential equations. May not be used toward any graduate degree offered by the department. P-MTH 605.

MST 611. Introductory Real Analysis I. (3 h)
Limits and continuity in metric spaces, sequences and series, differentiation and Riemann-Stieltjes integration, uniform convergence, power series and Fourier series, differentiation of vector functions, implicit and inverse function theorems.

MST 612. Introductory Real Analysis II. (3 h)
Limits and continuity in metric spaces, sequences and series, differentiation and Riemann-Stieltjes integration, uniform convergence, power series and Fourier series, differentiation of vector functions, implicit and inverse function theorems.

MST 617. Complex Analysis I. (3 h)
Analytic functions Caughy's theorem and its consequences, power series, and residue calculus.

MST 622. Modern Algebra II. (3 h)
A continuation of modern abstract algebra through the study of additional properties of groups, rings, and fields.

MST 624. Linear Algebra II. (3 h)
A thorough treatment of vector spaces and linear transformations over an arbitrary field, canonical forms. inner product spaces, and linear groups.

MST 626. Numerical Linear Algebra. (3 h)
An introduction to numerical methods for solving matrix and related problems in science and engineering using a high-level matrix-oriented language such as MATLAB. Topics include systems of linear equations, least squares methods, and eigenvalue computations. Special emphasis is given to applications.

MST 631. Geometry. (3 h)
An introduction to axiomatic geometry including a comparison of Euclidean and non-Euclidean geometries.

MST 634. Differential Geometry. (3 h)
Introduction to the theory of curves and surfaces in two and three dimensional space including such topics as curvature, geodesics, and minimal surfaces.

MST 645. Elementary Number Theory. (3 h)
Course topics include properties of integers, congruences, and prime numbers, with additional topics chosen from arithmetic functions, primitive roots, quadratic residues, Pythagorean triples, and sum of squares.

MST 646. Modern Number Theory. (3 h)
Course topics include a selection of number-theory topics of recent interest. Some examples include elliptic curves, partitions, modular forms, the Riemann zeta function, and algebraic number theory.

MST 647. Graph Theory. (3 h)
Paths, circuits, trees, planar graphs, spanning trees, graph coloring, perfect graphs, Ramsey theory, directed graphs, enumeration of graphs and graph theoretic algorithms.

MST 648. Combinatorial Analysis I. (3 h)
Enumeration techniques, generating functions, recurrence formulas, the principle of inclusion and exclusion, Polya theory, graph theory, combinatorial algorithms, partially ordered sets, designs, Ramsey theory, symmetric functions, and Schur functions.

MST 649. Combinatorial Analysis II. (3 h)
Enumeration techniques, generating functions, recurrence formulas, the principle of inclusion and exclusion, Polya theory, graph theory, combinatorial algorithms, partially ordered sets, designs, Ramsey theory, symmetric functions, and Schur functions.

MST 651. Intorduction to Mathematical Modeling. (3 h)
Introduction to the mathematicall modeling, analysis and simulation of continuous processes using MATLAB, Mathematica or Maple. Topics include dimensional analysis, stability analysis, bifucation theory, one-dimensional flows, phase plance analysis, index theory, limit cycles, chaotic dynamics, hyperbolic conservation laws and traveling waves.

MST 652. Partial Differential Equations. (3 h)
Detailed stduy of partial differential equations, including the heat, wave, and Laplace equations, using methods such as separation of variables, characteristics, Green's functions, and the maximum principle.

MST 654. Discrete Dynamical System. (3 h)
Introduction to the theory of discrete dynamical systems as applied to disciplines such as biology and economics. Includes methods for finding explicit solutions, equilibrium and stability analysis, phase plane analysis, analysis of Markov chains and bifurcation theory.

MST 655. Introduction to Numerical Methods. (3 h)
An introduction to numerical computations on modern computer architectures; floating point arithmetic and round-off error including programming in a scientific/engineering language such as MATLAB, Cor Fortran. Topics include algorithms and computer techniques for the solution of problems such as roots of fucntions, approximations, integration, systems of linear equations and least squares methods. Also listed as CSC 655.

MST 657. Probability. (3 h)
Distributions of discrete and continuous random variables, sampling distributions. Covers much of the material on the syllabus for the first actuarial exam. This course is cross-listed as STA 610.

MST 658. Mathematical Statistics. (3 h)
This course will cover derivation of point estimators, hypothesis testing, and confidence intervals using both maximum likelihood and Bayesian approaches. P - MST 657 or POI.

MST 681. Individual Study. (1, 2 h)
A course of independent study directed by a faculty adviser. By prearrangement. May be repeated for credit.

MST 682. Reading in Statistics. (1-3 h)
Reading in statistical topics to provide a foundational basis for more advanced study in a particular area. May not be used to satisfy any requirement in the MA degree with thesis. No more than three house may be applied to the requirements for the MA degree without thesis. May be repeated for credit for a total of 3 hours.

MST 683. Advanced Topics in Mathematics. (1-3 h)
Topics in mathematics that are not considered in regular courses. Content varies.

MST 711. Real Analysis. (3 h)
Measure and integration theory, elementary functional analysis, selected advanced topics in analysis.

MST 712. Real Analysis. (3 h)
Measure and integration theory, elementary functional analysis, selected advanced topics in analysis.

MST 715. Seminar in Analysis. (1 h)

MST 716. Seminar in Analysis. (1 h)

MST 717. Optimization in Banach Spaces. (3 h)
Banach and Hilbert spaces, best approximations, linear operators and adjoints, Frechet derivatives and nonlinear optimzation, fixed points and iterative methods,. Applications to control theory, mathematical programming, and numerical analysis.

MST 718. Topics in Analysis. (3 h)
Selected topics from functional analysis or analytic function theory.

MST 721. Abstract Algebra. (3 h)
Groups, rings, fields, extensions, Euclidean domains, polynomials, vector spaces, Galois theory.

MST 722. Abstract Algebra. (3 h)
Groups, rings, fields, extensions, Euclidean domains, polynomials, vector spaces, Galois theory.

MST 723. Seminar on Theory of Matrices. (1 h)

MST 724. Seminar on Theory of Matrices. (1 h)

MST 725. Seminar in Algebra. (1 h)

MST 726. Seminar in Algebra. (1 h)

MST 728. Topics in Algrbra. (3 h)
Topics vary and may include algebraic coding theory, algebraic number theory, matrix theory, representation theory, non-commutative ring theory.

MST 731. Topology. (3 h)
Point-set topology including topological spaces, continuity, connectedness, compactness, and metric spaces. Additional topics in topology may include classification of surface, algebraic topology, and knot theory.

MST 732. Topics in Topology and Geometry. (3 h)
Topics vary and may include knot theory, algebraic topology, differential topology, manifolds, and Riemannian geometry. May be repated for credit. P - 731 or POI.

MST 735. Seminar on Topology. (1 h)

MST 736. Seminar on Topology. (1 h)

MST 737. Seminar in Geometry. (1 h)

MST 738. Seminar on Geometry. (1 h)

MST 744. Topics in Number Theory. (3 h)
Topics vary and are chosen from the areas of analytic, algebraic, and elementary number theory. Topics may include Farey fractions, the theory of paritions, Waring's problem, prime number theorem, and Dirichlet's problem.

MST 745. Seminar on Number Theory. (1 h)

MST 746. Seminar on Number Theory. (1 h)

MST 747. Topics in Discrete Mathematics. (3 h)
Topics vary and may include enumerative combinatorics, graph theory, algebraic combinatorics, combinatorial optimization, coding theory, experimental designs, Ramsey theory, Polya theory, representational theory, set theory and mathematical logic.

MST 748. Seminar on Combinatorial Analysis. (1 h)

MST 749. Sem on Combinatorial Analysis. (1 h)

MST 750. Dynamical Systems. (3 h)
Introduction to modern theory of dynamical systems. Linear and nonlinear autonomous differential equations, invariant sets, closed orbits, Poincare maps, structural stability, center manifolds, normal forms, local bifurcactions of equilibria, linear and non-linear maps, hyperbolic sets, attractors, symbolic representation, fractal dimensions. P - MST 611.

MST 752. Topics in Applied Mathematics. (3 h)
Topics vary and may include computational methods in differential equations, optimization methods, approximation techinques, eigenvalue problems. May be repeated for credit.

MST 753. Nonlinear Optimization. (3 h)
The problem of finding global minimums of functions is addressed in the context of problems in which many local minima exist. Numerical techniques are emphasized, including gradient descent and quasi-Newton methods. Current literature is examined and a comparison made of various techniques for both unconstrained and constrained optimization problems. Credit no allowed for both MST 753 and CSC 753. P - MST 655 or CSC 655.

MST 754. Numerical Methods for Partial Differential Equations. (3 h)
Numerical techniques for solving partial differential equations (including elliptic, parabolic, and hyperbolic) are studied along with appplications to science and engineering. Theoretical foundations are described and emphasis is placed on algorithm design and implementation using either C, FORTRAN, or MATLAB. Credit not allowed for both MST 754 and CSC 754. P-MST 655 or CSC 655.

MST 757. Stochastic Processes and Applications. (3 h)
This course includes the axiomatic foundations of probability theory and an introduction to stochastic processes. Applications may include Markov chains, Markov Chain Monte Carlo with Metropolis-Hastings, Gibb sampling, Brownian motion, and related topics, with an emphasis on modern developments. This course is cross-listed as STA 710. P-MST 657 or STA 610 and MST 611 or POI.

MST 791. Thesis Research I. (1-9 h)
May be repeated for credit. Satisfactory/Unsatisfactory.

MST 792. Thesis Research II. (1-9 h)
May be repeated for credit. Satisfactory/Unsatisfactory.

Statistics

STA 610. Probability. (3 h)
Distributions of discrete and continuous random variables, sampling distributions. Covers much of the material on the syllabus for the first actuarial exam. This course is cross-listed as MST 657.

STA 611. Statistical Inference. (3 h)
Derivation of point estimators, hypothesis testing, and confidence intervals, using both frequentist and Bayesian approaches. P-STA 610 or MST 657 or POI.

STA 612. Linear Models. (3 h)
Theory of estimation and testing in linear models. Topics include least squares and the normal equations, the Gauss-Markov Theorem, testing general linear hypothesis, model selection, and applications. P-STA 610 or MST 657, or POI.

STA 652. Networks: Models and Analysis. (3 h)
A course in fundamental network theory concepts, including measures of network structure, community detection, clustering, and network modelling and inference. Topics also draw from recent advances in the analysis of networks and network data, as well as applications in economics, sociology, biology, computer science, and other areas.

STA 662. Multivariate Statistics. (3 h)
Multivariate and generalized linear methods for classification, visualization, discrimination, and analysis.

STA 663. Introduction to Statistical Learning. (3 h)
An introduction to supervised learning. Topics may include lasso and ridge regression, splines, generalized additive models, random forests, and support vector machines. Requires prior experience with R programming.

STA 664. Computational and Nonparametric Statistics. (3 h)
Computationally intensive methods to fit statistical models to data. Topics include simulation, Monte Carlo integration and Markov Chain Monte Carlo, sub-sampling, and nonparametric estimation and regression. P-MST 657 or POI.

STA 668. Time Series and Forecasting. (3 h)
Methods and models for time series processes and autocorrelated data. Topics include model diagnostics, ARMA models, spectral methods, computational considerations, and forecasting error. P-STA 610 or MST 657, or POI.

STA 679. Advanced Topics in Statistics. (1-3 h)
Topics in statistics not considered in regular courses or which continue study begun in regular courses. Content varies.

STA 682. Readings in Statistics. (1-3 h)
Reading in statistical topics to provide a foundational basis for more advanced study in a particular area. May not be used to satisfy any requirement in the MA degree with thesis. No more than three hours may be applied to the requirements for the MA degree without thesis. May be repeated for credit for a total of 3 hours.

STA 683. Individual Study. (1-3 h)
A course of independent study directed by a faculty adviser. By prearrangement.

STA 710. Stochastic Processes and Applications. (3 h)
This course includes the axiomatic foundations of probability theory and an introduction to stochastic processes. Applications may include Markov chains, Markov Chain Monte Carlo with Metropolis-Hastings, Gibbs sampling, Brownian motion, and related topics, with an emphasis on modern developments. This course is cross-listed as MST 757. P-STA 610 or MST 657 and MST 611 or POI.

STA 711. Advanced Statistical Inference. (3 h)
Advanced mathematical treatment of point estimators, hypothesis testings, and confidence intervals, using both frequentist and Bayesian approaches. P-STA 610 or MST 657, or POI.

STA 712. Generalized Linear Models. (3 h)
Extensions of the classical linear model to cover models for binary and count data, ordinal and nominal categorical data, and time-to-event data, along with numerical maximization techniques needed to fit such models. Additional topics may include longitudinal data, the Expectation-Maximization algorithm, non-linear models, or related topics. P-STA 612 or POI.

STA 720. Bayesian Analysis. (3 h)
Fundamental concepts, theory, and computational methods for Bayesian inference. Topics may include decision theory, evaluating Bayesian estimators, Bayesian testing and credible intervals, Markov chain Monte Carlo methods, and hierarchical models. P-STA 610 or MST 657, or POI.

STA 779. Topics in Statistics. (3 h)
Topics vary by instructor. May be repeated for credit.

STA 791. Thesis Research. (1-9 h)
May be repeated for credit. Satisfactory/Unsatisfactory. P-POI.

STA 792. Thesis Research. (1-9 h)
May be repeated for credit. Satisfactory/Unsatisfactory. P-POI.

Faculty

Program Director Jeremy Rouse
Chair Sarah Raynor
Associate Chair Robert Erhardt
Wake Forest Taylor Professor Stephen Robinson
Professors Edward Allen, Kenneth Berenhaut, Jennifer Erway Fey, Hugh Howards, Miaohua Jiang, Ellen E. Kirkman, Sarah Raynor
Sterge Faculty Fellows and Associate Professors Sarah Mason, Jeremy Rouse
Associate Professors Robert Erhardt, Staci Hepler, W. Frank Moore, R. Jason Parsley
Sterge Faculty Fellows and Assistant Professors Abbey Bourdon, John Gemmer
Assistant Professors Ciaran Evans, Claudia Falcon, Leandro Lichtenfelz, Lucy D'Agostino McGowan, John Holmes, Emily Huang, Sneha Jadhav,

Assistant Teaching Professors Justin Allman, Nicole Dalzell, Lynne Yengulalp
Visiting Assistant Professors Guillermo Alesandroni, Duff Baker-Jarvis, Zachary Letterhos, Qing Liu, Rajan Puri, Michael Roberts
Teacher-Scholar Postdoctoral Fellows Kaitlin Hill, Thomas Kindred, Tolulope Oke, Mostafa Rezapour, Lori Watson
Professor Emeritus and Part-time Instructor Richard Carmichael