DEPARTMENT OF MATHEMATICS AND STATISTICS

Geoffrey Martin, Interim Chair
Alessandro Arsie, Associate Chair
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For Graduate Admissions, please contact the department office

A full description of programs and requirements, with syllabi for exams, is available from the department office or on its Website (https://www.utoledo.edu/nsm/mathstats/). The paragraphs below represent a synopsis of the essential elements.

Mission

The mission of the Department of Mathematics and Statistics is to prepare students for careers or further academic programs in mathematics, statistics, actuarial science or data science. To that end we offer academic programs in these fields at bachelor's, master's and doctoral levels. Via these programs, students are enabled to establish careers in education, business, industry and government. Students at advanced levels graduate with ability to independently investigate mathematical and statistical problems at the forefront of our discipline.

The department is also committed to fostering success for all students across the university by offering courses in mathematics that enhance their foundations in quantitative skills for the wide range of their collegiate coursework as well as critical life skills after they graduate. Finally, the department is committed to enhancing the university's research profile and capabilities by offering assistance in statistics and mathematics to research faculty and students across the campus.

General description

The Department of Mathematics and Statistics is a comprehensive academic unit offering a full range of programs across the disciplines and at all academic levels. We have 18 tenured/tenure-track faculty and 18 teaching faculty in the position of lecturer, along with several faculty in visiting and other part-time positions. We have graduate students at all levels numbering approximately 45. In addition to pure and applied mathematics and statistics at all levels, we also offer undergraduate programs in actuarial science, mathematics with computer science, and data science. Our Statistical Consulting Service provides assistance to researchers across the campus and the community. Our department is fully engaged with the Ohio department of Higher Education and the public institutions of higher education in Ohio in the Ohio Math Initiative. In the context of that initiative and other efforts, we are fully committed to fostering student success across the campus.

Degrees Offered

- MA in Mathematics (http://utoledo-public.courseleaf.com/graduate/natural-sciences-mathematics/departments/mathematics-statistics/ma-mathematics/)
- MAE in Mathematics (http://utoledo-public.courseleaf.com/graduate/natural-sciences-mathematics/departments/mathematics-statistics/mae-mathematics/)
- MS in Mathematics (http://utoledo-public.courseleaf.com/graduate/natural-sciences-mathematics/departments/mathematics-statistics/ms-mathematics/)
- MSE in Mathematics (http://utoledo-public.courseleaf.com/graduate/natural-sciences-mathematics/departments/mathematics-statistics/mse-mathematics/)
- PhD in Mathematics (http://utoledo-public.courseleaf.com/graduate/natural-sciences-mathematics/departments/mathematics-statistics/phd-mathematics/)

MATH 5010 Functions And Modeling For Middle Grade Mathematics
[3 credit hours]
Introduction to the theory of functions through modeling. Subjects include polynomial, exponential, logarithmie and rational functions, interpolation and modeling of data sets though least squares and other methods. Graduate math credit for education students only.

MATH 5040 Concepts Of Calculus For Middle Grade Mathematics
[3 credit hours]
Introduction to the basic idea of calculus. Subjects include limits, continuity, the derivative and its applications, indefinite and definite integral, Fundamental Theorem of Calculus, evaluation of integrals. Graduate math credit for education students only.
Term Offered: Summer

MATH 5060 Number Theory Concepts For Middle Grade Mathematics
[3 credit hours]
Introduction to basic number theory. Subjects include history of number theory, prime numbers, unique factorization, Euclidean algorithm, Pythagorean relations, number systems, and transformations. Graduate math credit for education students only.

MATH 5070 Geometry Concepts For Middle School Mathematics
[3 credit hours]
Descriptive geometry in 2 and 3 dimensions, use of axioms and definitions in the proof theorems, formal Euclidean geometry, transformations. Graduate math credit for education students only.

MATH 5080 History Of Mathematics For Middle Grade Mathematics
[3 credit hours]
Study of the history of mathematics from antiquity to the 20th century concentrating on the development of arithmetic, algebra, geometry and calculus. Graduate math credit for education students only.

MATH 5110 Probability Concepts For Middle Grade Mathematics
[3 credit hours]
Introduction to the theory of probability, counting principles and combinatorics, risk, coincidence, expectation and conditional probability, probability distributions. Graduate math credit for education students only.

MATH 5120 Statistics Concepts For Middle Grade Mathematics
[3 credit hours]
Introduction to the fundamental ideas of statistics, including sampling techniques, descriptive, variance, confidence intervals, correlation and regression. Graduate math credit for education students only.

MATH 5220 Theory Of Interest
[3 credit hours]
This course covers the measurement of interest, certain annuities, yield rates, amortization and sinking funds, bonds and other securities and application of interest theory.

MATH 5260 Actuarial Mathematics I
[3 credit hours]
Survival distributions and life tables, life insurance, life annuities, benefit premiums and reserves and multiple life functions are some topics covered in this course.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Fall

MATH 5300 Linear Algebra I
[3 credit hours]
Theory of vector spaces and linear transformations, including such topics as matrices, determinants, inner products, eigenvalues and eigenvectors, and rational and Jordan canonical forms.
Term Offered: Fall

MATH 5310 Linear Algebra II
[3 credit hours]
Hermitian and normal operators, multilinear forms, spectral theorem and other topics.
Prerequisites: MATH 5300 with a minimum grade of D-

MATH 5330 Abstract Algebra I
[3 credit hours]
Arithmetic of the integers, unique factorization and modular arithmetic; group theory including normal subgroups, factor groups, cyclic groups, permutations, homomorphisms, the isomorphism theorems, abelian groups and p-groups.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 5340 Abstract Algebra II
[3 credit hours]
Ring theory including integral domains, field of quotients, homomorphisms, ideals, Euclidean domains, polynomial rings, vector spaces, roots of polynomials and field extensions.
Prerequisites: MATH 5330 with a minimum grade of D-
Term Offered: Spring

MATH 5350 Applied Linear Algebra
[3 credit hours]
Matrices, systems of equations, vector spaces, linear transformations, determinants, eigenvalues and eigenvectors, generalized inverses, rank, numerical methods and applications to various areas of science.
Prerequisites: MATH 1890 with a minimum grade of D-
Term Offered: Spring, Summer

MATH 5380 Discrete Structures And Analysis Algorithms
[3 credit hours]
Discrete mathematical structures for applications in computer science such as graph theory, combinatorics, groups theory, asymptotics, recurrence relations and analysis of algorithms.
Prerequisites: MATH 3320 with a minimum grade of D- or MATH 5330 with a minimum grade of D-
Term Offered: Fall

MATH 5450 Introduction To Topology I
[3 credit hours]
Metric spaces, topological spaces, continuous maps, bases and sub-bases, closure and interior operators, products, subspaces, sums, quotients, separation axioms, compactness and local compactness.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 5460 Introduction To Topology II
[3 credit hours]
Connectedness and local connectedness, convergence, metrization, function spaces. The fundamental groups and its properties, covering spaces, classical applications, e.g. Jordan Curve Theorem, Fundamental Theorem of Algebra, Brouwer's Fixed Point Theorem.
Prerequisites: MATH 5450 with a minimum grade of D-
Term Offered: Spring

MATH 5540 Classical Differential Geometry I
[3 credit hours]
Smooth curves in Euclidean space including the Frenet formulae. Immersed surfaces with the Gauss map, principal curvatures and the fundamental forms. Special surfaces including ruled surfaces and minimal surfaces. Intrinsic Geometry including the Gauss Theorem Egregium.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-

MATH 5550 Classical Differential Geometry II
[3 credit hours]
Tensors, vector fields and the Cartan approach to surface theory, Bonnet's Theorem and the construction of surfaces via solutions of the Gauss Equation. Geodesics, parallel transport and Jacobi Fields. Theorems of a global nature such as Hilbert's Theorem or the Theorem of Hopf-Rinow.
Prerequisites: MATH 5540 with a minimum grade of D-

MATH 5600 Advanced Statistical Methods I
[3 credit hours]
Basics of descriptive statistics, study designs and statistical inference. Properties of, and assumptions required for, inference for means, variances, and proportions from one and two-sample paired and unpaired studies. Introduction to ANOVA with multiple comparisons and multiple regression. Model assessment and diagnostics. Statistical software will be employed. Opportunities to apply procedures to real data. Emphasis placed on the foundations to approaches in introductory statistics.
Term Offered: Fall

MATH 5610 Advanced Statistical Methods II
[3 credit hours]
Statistical/biostatistical concepts and methods. Broad subject categories that may be included are study design, longitudinal data analysis, survival analysis, logistic regression, random and mixed effects models. Other topics applicable to current statistical consulting projects, or related to modern data analytics, may be introduced. Appropriate statistical software will be employed.
Prerequisites: MATH 5600 with a minimum grade of C-
Term Offered: Spring

MATH 5620 Linear Statistical Models
[3 credit hours]
Multiple regression, analysis of variance and covariance, general linear models and model building for linear models. Experimental designs include one-way, randomized block, Latin square, factorial and nested designs.
Prerequisites: MATH 6650 with a minimum grade of D-
Term Offered: Spring

MATH 5630 Theory And Methods Of Sample Surveys
[3 credit hours]
The mathematical basis to estimation in various sampling contexts, including probability proportional to size sampling, stratified sampling, two-stage cluster sampling and double sampling, is developed.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 5640 Statistical Computing
[3 credit hours]
Modern statistical computing, including programming tools, modern programming methodologies, design of data structures and algorithms, numerical computing and graphics. Additional topics selected from simulation studies, inversion of probability integral transforms, rejection sampling, importance sampling, Monte Carlo integration, bootstrapping and optimization.
Term Offered: Fall

MATH 5680 Introduction To Theory Of Probability
[3 credit hours]
Probability spaces, random variables, probability distributions, moments and moment generating functions, limit theorems, transformations and sampling distributions.
Prerequisites: (MATH 3190 with a minimum grade of D- and MATH 5350 with a minimum grade of D-)
Term Offered: Summer, Fall

MATH 5690 Introduction To Mathematical Statistics
[3 credit hours]
Sampling distributions, point estimation, interval estimation, hypothesis testing, regression and analysis of variance.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Spring

MATH 5710 Methods Of Numerical Analysis I
[3 credit hours]
Floating point arithmetic; polynomial interpolation; numerical solution of nonlinear equations; Newton's method. Likely topics include: numerical differentiation and integration; solving systems of linear equations; Gaussian elimination; LU decomposition; Gauss-Seidel method.
Term Offered: Spring, Fall

MATH 5720 Methods Of Numerical Analysis II
[3 credit hours]
Likely topics include: Computation of eigenvalues and eigenvectors; solving systems of nonlinear equations; least squares approximations; rational approximations; cubic splines; fast Fourier transforms; numerical solutions to initial value problems; ordinary and partial differential equations.
Prerequisites: MATH 5710 with a minimum grade of D-
Term Offered: Spring

MATH 5740 Advanced Applied Mathematics I
[3 credit hours]
Series and numerical solutions to ordinary differential equations, special functions, orthogonal functions, Sturm-Liouville Problems, self-adjointness, vector analysis.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-
Term Offered: Fall

MATH 5750 Advanced Applied Mathematics II
[3 credit hours]
Continuation of vector analysis, introduction to complex analysis, partial differential equations, Fourier series and integrals.
Prerequisites: MATH 5740 with a minimum grade of D-
Term Offered: Spring

MATH 5780 Advanced Calculus
[3 credit hours]
Extrema for functions of one or more variables, Lagrange multipliers, indeterminate forms, inverse and implicit function theorems, uniform convergences, power series, transformations, Jacobians, multiple integrals.
Prerequisites: MATH 2850 with a minimum grade of D-

MATH 5800 Ordinary Differential Equations
[3 credit hours]
Modern theory of differential equations; transforms and matrix methods; existence theorems and series solutions; and other selected topics.
Prerequisites: MATH 2860 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 5810 Partial Differential Equations
[3 credit hours]
First and second order equations; numerical methods; separation of variables; solutions of heat and wave equations using eigenfunction techniques; and other selected topics.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-
Term Offered: Spring

MATH 5820 Introduction To Real Analysis I
[3 credit hours]
A rigorous treatment of the Calculus in one and several variables. Topics to include: the real number system; sequences and series; elementary metric space theory including compactness, connectedness and completeness; the Riemann Integral.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 5830 Introduction To Real Analysis II
[3 credit hours]
Differentiable functions on Rn; the Implicit and Inverse Function Theorems; sequences and series of continuous functions; Stone-Weierstrass Theorem; Arsela-Ascoli Theorem; introduction to measure theory; Lebesgue integration; the Lebesgue Dominated Convergence Theorem.
Prerequisites: MATH 5820 with a minimum grade of D-
Term Offered: Spring

MATH 5860 Calculus Of Variations And Optimal Control Theory I
[3 credit hours]
Conditions for an extreme (Euler's equations, Erdman corner conditions, conditions of Legendre, Jacobi and Weierstrass, fields of extremals, Hilbert's invariant integral);); Raleigh-Ritz method; isoperimetric problems; Lagrange, Mayer-Bolza problems. Recommended: MATH 5820.
Prerequisites: MATH 1890 with a minimum grade of D-
Term Offered: Fall

MATH 5870 Calculus Of Variations And Optimal Control Theory II
[3 credit hours]
Pontryagin's maximum principle; necessary and sufficient conditions for optimal control, controllability, time optimal control, existence of optimal controls, relationship to the calculus of variations.
Prerequisites: MATH 5860 with a minimum grade of D-
Term Offered: Spring

MATH 5880 Complex Variables
[3 credit hours]
Analytic functions; Cauchy's theorem; Taylor and Laurent series; residues; contour integrals; conformal mappings, analytic continuation and applications.
Prerequisites: MATH 2860 with a minimum grade of D-
Term Offered: Spring, Summer

MATH 5970 Industrial Math Practicum
[1 credit hour]
Students must submit for approval by their adviser a report on the solution of a practical problem involving mathematics. The problem must be drawn from a company, university department of government unit.

MATH 5980 Topics In Mathematics
[3 credit hours]
Special topics in mathematics.
Term Offered: Spring, Summer

MATH 6180 Linear And Nonlinear Programming
[3 credit hours]
Simplex algorithm, ellipsoidal algorithm, Karmarkar's method, interior point methods, elementary convex analysis, optimality conditions and duality for smooth problems, convex programming, algorithms and their convergence.
Prerequisites: MATH 5820 with a minimum grade of D-

MATH 6190 Infinite Dimensional Optimization
[3 credit hours]
Introduction to nonlinear analysis, abstract optimization problems on abstract spaces, applications to calculus of variations, optimal control theory and game theory.

MATH 6300 Algebra I
[3 credit hours]
Group actions, Sylow's theorems, permutation groups, nilpotent and solvable groups, abelian groups, rings, unique factorization domains, fields.
Prerequisites: MATH 5340 with a minimum grade of D-
Term Offered: Fall

MATH 6310 Algebra II
[3 credit hours]
Field extensions, Galois theory, modules, Noetherian and Artinian rings, tensor products, primitive rings, semisimple rings and modules, the Wedderburn-Artin theorem.
Prerequisites: MATH 6300 with a minimum grade of D-
Term Offered: Spring

MATH 6400 Topology I
[3 credit hours]
Topological spaces, continuous functions, compactness, product spaces, Tychonov's theorem, quotient spaces, local compactness, homotopy theory, the fundamental group, covering spaces.
Prerequisites: MATH 4450 with a minimum grade of D- or MATH 5450 with a minimum grade of D- or MATH 7450 with a minimum grade of D-
Term Offered: Fall

MATH 6410 Topology II
[3 credit hours]
Homology theory, excision, homological algebra, the Brouwer fixed point theorem, cohomology, differential manifolds, orientation, tangent bundles, Sard's theorem, degree theory.
Prerequisites: MATH 6400 with a minimum grade of D-
Term Offered: Spring

MATH 6440 Differential Geometry I
[3 credit hours]
Introduction to differential geometry. Topics include differentiable manifolds, vector fields, tensor bundles, the Frobenius theorem, Stokes' theorem, Lie groups.
Prerequisites: MATH 6410 with a minimum grade of D-
Term Offered: Fall

MATH 6450 Differential Geometry II
[3 credit hours]
Topics include connections on manifolds, Riemannian geometry, the Gauss-Bonnet theorem. Further topics may include: homogeneous and symmetric spaces, minimal surfaces, Morse theory, comparison theory, vector and principal bundles.
Prerequisites: MATH 6440 with a minimum grade of D-
Term Offered: Spring

MATH 6500 Ordinary Differential Equations
[3 credit hours]
Existence, uniqueness and dependence on initial conditions and parameter, nonlinear planar systems, linear systems, Floquet theory, second order equations, Sturm-Liouville theory.
Term Offered: Summer, Fall

MATH 6510 Partial Differential Equations
[3 credit hours]
First order quasi-linear systems of partial differential equations, boundary value problems for the heat and wave equation, Dirichlet problem for Laplace equation, fundamental solutions for Laplace, heat and wave equations.
Term Offered: Spring, Summer

MATH 6520 Dynamical Systems I
[3 credit hours]
Topic include the flow-box theorem, Poincare maps, attractors, w limit sets, Lyapunov stability, invariant submanifolds, Hamiltonian systems and symplectic manifolds.
Prerequisites: MATH 6500 with a minimum grade of D-

MATH 6530 Dynamical Systems II
[3 credit hours]
Topics may include local bifurcations of vector fields, global stability, ergodic theorems, integrable systems, symbolic dynamics, chaos theory.
Prerequisites: MATH 6520 with a minimum grade of D-

MATH 6600 Statistical Consulting
[1-5 credit hours]
Real data applications of various statistical methods, project design and analysis including statistical consulting experience. May be repeated for credit.
Term Offered: Spring, Fall

MATH 6610 Statistical Consulting II
[3 credit hours]
Real data applications of various statistical methods, project design and analysis including statistical consulting experience.
Term Offered: Spring

MATH 6620 Categorical Data Analysis
[3 credit hours]
Important methods and modeling techniques using generalized linear models and emphasizing loglinear and logit modeling.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 6630 Nonparametric Statistics
[3 credit hours]
Statistical methods based on counts and ranks; methods designed to be effective in the presence of contaminated data or error distribution misspecification.
Prerequisites: MATH 5680 with a minimum grade of C-
Term Offered: Spring, Fall

MATH 6640 Topics In Statistics
[3 credit hours]
Topics selected from an array of modern statistical methods such as survival analysis, nonlinear regression, Monte Carlo methods, etc.
Term Offered: Spring, Fall

MATH 6650 Statistical Inference
[3 credit hours]
Estimation, hypothesis testing, prediction, sufficient statistics, theory of estimation and hypothesis testing, simultaneous inference, decision theoretic models.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Fall

MATH 6670 Measure Theoretic Probability
[3 credit hours]
Real analysis, probability spaces and measures, random variables and distribution functions, independence, expectation, law of large numbers, central limit theorem, zero-one laws, characteristic functions, conditional expectations given a s-algebra, martingales.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Fall

MATH 6680 Theory Of Statistics
[3 credit hours]
Exponential families, sufficiency, completeness, optimality, equivariance, efficiency. Bayesian and minimax estimation. Unbiased and invariant tests, uniformly most powerful tests. Asymptotic properties for estimation and testing. Most accurate confidence intervals.
Prerequisites: MATH 5960 with a minimum grade of D- or (MATH 6650 with a minimum grade of D- and MATH 6670 with a minimum grade of D-)
Term Offered: Spring

MATH 6690 Multivariate Statistics
[3 credit hours]
Multivariate normal sampling distributions, T tests and MANOVA, tests on covariance matrices, simultaneous inference, discriminant analysis, principal components, cluster analysis and factor analysis.
Prerequisites: MATH 5690 with a minimum grade of D- or MATH 6650 with a minimum grade of D-
Term Offered: Spring

MATH 6720 Methods Of Mathematical Physics I
[3 credit hours]
Analytic functions, residues, method of steepest descent, complex differential equations, regular singularities, integral representation, real and complex vector spaces, matrix groups, Hilbert spaces, coordinate transformations.
Term Offered: Fall

MATH 6730 Methods Of Mathematical Physics II
[3 credit hours]
Self-adjoint operators, special functions, orthogonal polynomials, partial differential equations and separation of variables, boundary value problems, Green¿s functions, integral equations, tensor analysis, metrics and curvature, calculus of variations, finite groups and group representations.
Prerequisites: MATH 6720 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 6800 Real Analysis I
[3 credit hours]
Completeness, connectedness and compactness in metric spaces, continuity and convergence, the Stone-Weierstrass Theorem, Lebesgue measure and integration on the real line, convergence theorems, Egorov's and Lusin's theorems, derivatives, functions of bounded variation.
Prerequisites: MATH 4830 with a minimum grade of D- or MATH 5830 with a minimum grade of D-
Term Offered: Fall

MATH 6810 Real Analysis II
[3 credit hours]
The Vitali covering theorem, absolutely continuous functions, Lebesgue-Stieltjes integration, the Riesz representation theorem , Banach spaces, Lp-spaces, abstract measures, the Radon-Nikodym theorem, measures on locally compact Hausdorff spaces.
Prerequisites: MATH 6800 with a minimum grade of D-
Term Offered: Spring

MATH 6820 Functional Analysis I
[3 credit hours]
Topics include Topological vector spaces, Banach spaces, convexity, the Hahn-Banch theorem, weak and strong topologies, Lp spaces and duality.
Prerequisites: MATH 6810 with a minimum grade of D-
Term Offered: Fall

MATH 6830 Functional Analysis II
[3 credit hours]
Topics include the Mackey-Ahrens Theorem, Banach algebras, spectra in Banach algebras, commutative Banach algebras, unbounded operators, the spectral theorem, topics in functional analysis.
Prerequisites: MATH 6820 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 6840 Complex Analysis I
[3 credit hours]
Elementary analytic functions, complex integration, the residue theorem, infinite sequences of analytic functions, Laurent expansions, entire functions.
Prerequisites: MATH 6800 with a minimum grade of D-
Term Offered: Fall

MATH 6850 Complex Analysis II
[3 credit hours]
Meromorphic functions, conformal mapping, harmonic functions and the dirichlet problem, the Riemann mapping theorem, monodromy, algebraic functions, Riemann surfaces, elliptic functions and the modular function.
Prerequisites: MATH 6840 with a minimum grade of D-
Term Offered: Spring

MATH 6860 Measure Theoretic Probability I
[3 credit hours]
Focus on measure theory and probability. Measures and their extensions, integration, convergence theorems, product measures. Probability spaces, random variables and distribution functions, independence, expectation, law of large numbers, central limit theorem, zero-one laws, characteristic functions.
Prerequisites: MATH 5680 with a minimum grade of D-
Corequisites: MATH 6800

MATH 6870 Nonlinear Analysis I
[3 credit hours]
The instructor will select a subset among the following topics: Finite-dimensional degree theory, some applications to nonlinear equations. Preliminaries on Operator Theory and Differential Calculus in Normed Spaces; Topological Degree in Banach Spaces (Schuder fixed point theorem and Leray-Schauder theory) , non-resonance and topological degree, Lazer-Leach conditions and variations, variational techniques including Ekeland principle and its applications and Mountain Pass theorem, resonance and periodic solutions, Lusternik-Schnirelmann Theory, Poincare'-Birkhoff Theorem. Bifurcation theory: Morse lemma and its applications. Rabinowitz theorem and Krasnoselski theorem and its applications. Stability of solutions and number of global solutions to a nonlinear problem.
Prerequisites: MATH 6500 with a minimum grade of D- and MATH 6510 with a minimum grade of D-
Term Offered: Fall

MATH 6880 Nonlinear Analysis II
[3 credit hours]
The instructor will select a subset among the following topics: Geometric singular perturbation theory. Further topological methods: extensions of Leray-Schauder degree and applications to partial differential equations. Framed cobordism and stable cohomotopy theorem. Applications to existence of global solutions. Monotone operators and mini-max theorem. Generalized implicit function theorems, KAM and Conjugacy problems. Critical Points Theory and Hamiltonian Systems Topological Degree methods in Nonlinear Boundary Value Problems Normal forms, center manifold reduction and bifurcations in infinite dimensional dynamical systems.
Prerequisites: MATH 6500 with a minimum grade of D- and MATH 6510 with a minimum grade of D- and MATH 6870 with a minimum grade of D-
Term Offered: Spring

MATH 6930 Colloquium
[1 credit hour]
Lectures by visiting mathematicians and staff members on areas of current interest in mathematics.
Term Offered: Spring, Fall

MATH 6940 Proseminar
[1-5 credit hours]
Problems and techniques of teaching elementary college mathematics, supervised teaching, seminar in preparation methods.
Term Offered: Spring, Fall

MATH 6960 Master Thesis
[3-6 credit hours]

MATH 6980 Topics In Mathematical Sciences
[3 credit hours]
Special topics in Mathematics or Statistics.
Term Offered: Spring, Summer, Fall

MATH 6990 Readings In Mathematics
[1-5 credit hours]
Readings in areas of Mathematics of mutual interest to the student and the professor.
Term Offered: Spring, Summer, Fall

MATH 7300 Linear Algebra I
[3 credit hours]
Theory of vector spaces and linear transformations, including such topics as matrices, determinants, inner products, eigenvalues and eigenvectors, and rational and Jordan canonical forms.
Term Offered: Fall

MATH 7310 Linear Algebra II
[3 credit hours]
Hermitian and normal operators, multilinear forms, spectral theorem and other topics.
Prerequisites: MATH 5300 with a minimum grade of D-

MATH 7330 Abstract Algebra I
[3 credit hours]
Arithmetic of the integers, unique factorization and modular arithmetic; group theory including normal subgroups, factor groups, cyclic groups, permutations, homomorphisms, the isomorphism theorems, abelian groups and p-groups.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 7340 Abstract Algebra II
[3 credit hours]
Ring theory including integral domains, field of quotients, homomorphisms, ideals, Euclidean domains, polynomial rings, vector spaces, roots of polynomials and field extensions.
Prerequisites: MATH 5330 with a minimum grade of D-
Term Offered: Spring

MATH 7350 Applied Linear Algebra
[3 credit hours]
Matrices, systems of equations, vector spaces, linear transformations, determinants, eigenvalues and eigenvectors, generalized inverses, rank, numerical methods and applications to various areas of science.
Prerequisites: MATH 1890 with a minimum grade of D-
Term Offered: Spring

MATH 7380 Discrete Structures And Analysis Algorithms
[3 credit hours]
Discrete mathematical structures for applications in computer science such as graph theory, combinatorics, groups theory, asymptotics, recurrence relations and analysis of algorithms.
Prerequisites: MATH 3320 with a minimum grade of D- or MATH 5330 with a minimum grade of D-
Term Offered: Fall

MATH 7450 Introduction To Topology I
[3 credit hours]
Metric spaces, topological spaces, continuous maps, bases and sub-bases, closure and interior operators, products, subspaces, sums, quotients, separation axioms, compactness and local compactness.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 7460 Introduction To Topology II
[3 credit hours]
Connectedness and local connectedness, convergence, metrization, function spaces. The fundamental groups and its properties, covering spaces, classical applications, e.g. Jordan Curve Theorem, Fundamental Theorem of Algebra, Brouwer's Fixed Point Theorem.
Prerequisites: MATH 5450 with a minimum grade of D-
Term Offered: Spring

MATH 7540 Classical Differential Geometry I
[3 credit hours]
Smooth curves in Euclidean space including the Frenet formulae. Immersed surfaces with the Gauss map, principal curvatures and the fundamental forms. Special surfaces including ruled surfaces and minimal surfaces. Intrinsic Geometry including the Gauss Theorem Egregium.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-

MATH 7550 Classical Differential Geometry II
[3 credit hours]
Tensors, vector fields and the Cartan approach to surface theory, Bonnet's Theorem and the construction of surfaces via solutions of the Gauss Equation. Geodesics, parallel transport and Jacobi Fields. Theorems of a global nature such as Hilbert's Theorem or the Theorem of Hopf-Rinow.
Prerequisites: MATH 5540 with a minimum grade of D-

MATH 7600 Advanced Statistical Methods I
[3 credit hours]
Basics of descriptive statistics, study designs and statistical inference. Properties of, and assumptions required for, inference for means, variances, and proportions from one and two-sample paired and unpaired studies. Introduction to ANOVA with multiple comparisons and logistic and multiple regression. Model assessment and diagnostics. Statistical software will be employed. Opportunities to apply procedures to real data. Emphasis placed on the foundations to approaches in introductory statistics.
Term Offered: Fall

MATH 7610 Advanced Statistical Methods II
[3 credit hours]
Statistical/biostatistical concepts and methods. Broad subject categories that may be included are study design, longitudinal data analysis, survival analysis, logistic regression, random and mixed effects models and Bayesian Statistics. Other topics applicable to current statistical consulting projects, or related to modern data analytics, may be introduced. Appropriate statistical software will be employed.
Prerequisites: MATH 5600 with a minimum grade of C-
Term Offered: Spring

MATH 7620 Linear Statistical Models
[3 credit hours]
Multiple regression, analysis of variance and covariance, general linear models and model building for linear models. Experimental designs include one-way, randomized block, Latin square, factorial and nested designs.
Prerequisites: MATH 6650 with a minimum grade of D-
Term Offered: Spring

MATH 7630 Theory And Methods Of Sample Surveys
[3 credit hours]
The mathematical basis to estimation in various sampling contexts, including probability proportional to size sampling, stratified sampling, two-stage cluster sampling and double sampling, is developed.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Spring

MATH 7640 Statistical Computing
[3 credit hours]
Modern statistical computing, including programming tools, modern programming methodologies, design of data structures and algorithms, numerical computing and graphics. Additional topics selected from simulation studies, inversion of probability integral transforms, rejection sampling, importance sampling, Monte Carlo integration, bootstrapping and optimization.
Term Offered: Fall

MATH 7680 Introduction To Theory Of Probability
[3 credit hours]
Probability spaces, random variables, probability distributions, moments and moment generating functions, limit theorems, transformations and sampling distributions.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 7690 Introduction To Mathematical Statistics
[3 credit hours]
Sampling distributions, point estimation, interval estimation, hypothesis testing, regression and analysis of variance.
Prerequisites: MATH 5680 with a minimum grade of D-
Term Offered: Spring

MATH 7710 Methods Of Numerical Analysis I
[3 credit hours]
Floating point arithmetic; polynomial interpolation; numerical solution of nonlinear equations; Newton's method. Likely topics include: numerical differentiation and integration; solving systems of linear equations; Gaussian elimination; LU decomposition; Gauss-Seidel method.
Term Offered: Fall

MATH 7720 Methods Of Numerical Analysis II
[3 credit hours]
Likely topics include: Computation of eigenvalues and eigenvectors; solving systems of nonlinear equations; least squares approximations; rational approximations; cubic splines; fast Fourier transforms; numerical solutions to initial value problems; ordinary and partial differential equations.
Prerequisites: MATH 5710 with a minimum grade of D-
Term Offered: Spring

MATH 7740 Advanced Applied Mathematics I
[3 credit hours]
Series and numerical solutions to ordinary differential equations, special functions, orthogonal functions, Sturm-Liouville Problems, self-adjointness, vector analysis.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-
Term Offered: Fall

MATH 7750 Advanced Applied Mathematics II
[3 credit hours]
Continuation of vector analysis, introduction to complex analysis, partial differential equations, Fourier series and integrals.
Prerequisites: MATH 5740 with a minimum grade of D-
Term Offered: Spring

MATH 7800 Ordinary Differential Equations
[3 credit hours]
Modern theory of differential equations; transforms and matrix methods; existence theorems and series solutions; and other selected topics.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-
Term Offered: Fall

MATH 7810 Partial Differential Equations
[3 credit hours]
First and second order equations; numerical methods; separation of variables; solutions of heat and wave equations using eigenfunction techniques; and other selected topics.
Prerequisites: MATH 3860 with a minimum grade of D- or MATH 2860 with a minimum grade of D-
Term Offered: Spring

MATH 7820 Introduction To Real Analysis I
[3 credit hours]
A rigorous treatment of the Calculus in one and several variables. Topics to include: the real number system; sequences and series; elementary metric space theory including compactness, connectedness and completeness; the Riemann Integral.
Prerequisites: MATH 3190 with a minimum grade of D-
Term Offered: Fall

MATH 7830 Introduction To Real Analysis II
[3 credit hours]
Differentiable functions on Rn; the Implicit and Inverse Function Theorems; sequences and series of continuous functions; Stone-Weierstrass Theorem; Arsela-Ascoli Theorem; introduction to measure theory; Lebesgue integration; the Lebesgue Dominated Convergence Theorem.
Prerequisites: MATH 5820 with a minimum grade of D-
Term Offered: Spring

MATH 7860 Calculus Of Variations And Optimal Control Theory I
[3 credit hours]
Conditions for an extreme (Euler's equations, Erdman corner conditions, conditions of Legendre, Jacobi and Weierstrass, fields of extremals, Hilbert's invariant integral); Raleigh-Ritz method; isoperimetric problems; Lagrange, Mayer-Bolza problems.
Prerequisites: MATH 5820 with a minimum grade of D-

MATH 7870 Calculus Of Variations And Optimal Control Theory II
[3 credit hours]
Pontryagin's maximum principle; necessary and sufficient conditions for optimal control, controllability, time optimal control, existence of optimal controls, relationship to the calculus of variations.
Prerequisites: MATH 5860 with a minimum grade of D-

MATH 7880 Complex Variables
[3 credit hours]
Analytic functions; Cauchy's theorem; Taylor and Laurent series; residues; contour integrals; conformal mappings, analytic continuation and applications.
Prerequisites: MATH 3860 with a minimum grade of D-
Term Offered: Spring

MATH 7980 Topics In Mathematics
[3 credit hours]
Special topics in mathematics.

MATH 8180 Linear And Nonlinear Programming
[3 credit hours]
Simplex algorithm, ellipsoidal algorithm, Karmarkar's method, interior point methods, elementary convex analysis, optimality conditions and duality for smooth problems, convex programming, algorithms and their convergence.
Prerequisites: MATH 5820 with a minimum grade of D- or MATH 7820 with a minimum grade of D-

MATH 8190 Infinite Dimensional Optimization
[3 credit hours]
Introduction to nonlinear analysis, abstract optimization problems on abstract spaces, applications to calculus of variations, optimal control theory and game theory.
Prerequisites: MATH 6150 with a minimum grade of D- or MATH 6810 with a minimum grade of D- or MATH 8150 with a minimum grade of D- or MATH 8810 with a minimum grade of D-

MATH 8300 Algebra I
[3 credit hours]
Group actions, Sylow's theorems, permutation groups, nelpotent and solvable groups, abelian groups, rings, unique factorization domains, fields.
Prerequisites: MATH 5340 with a minimum grade of D- or MATH 7340 with a minimum grade of D-
Term Offered: Fall

MATH 8310 Algebra II
[3 credit hours]
Field extensions, Galois theory, modules, Noetherian and Artinian rings, tensor products, primitive rings, semisimple rings, and modules, the Wedderburn-Artin theorem.
Prerequisites: MATH 6300 with a minimum grade of D- or MATH 8300 with a minimum grade of D-
Term Offered: Spring

MATH 8320 Ring Theory I
[3 credit hours]
Radical theory, rings of quotients, Goldie's Theorem, chain conditions, dimensions of rings, module theory, topics in commutative rings.
Prerequisites: MATH 6310 with a minimum grade of D- or MATH 8310 with a minimum grade of D-

MATH 8330 Ring Theory II
[3 credit hours]
Advanced topics in ring theory. Possible topics include group rings, enveloping algebras, almost split sequences, PI-rings, division rings, self-injective rings, and ordered rings.
Prerequisites: MATH 6310 with a minimum grade of D- or MATH 8310 with a minimum grade of D-

MATH 8340 Group Theory I
[3 credit hours]
Fundamental topics in group theory. Possible topics include free groups, presentations, free products and amalgams, permutation groups, abelian groups, nilpotent and solvable groups, subnormality, extensions, the Schur-Zassenhaus theorem, the transfer homomorphism, linear methods, local analysis.
Prerequisites: MATH 6310 with a minimum grade of D- or MATH 8310 with a minimum grade of D-

MATH 8350 Group Theory II
[3 credit hours]
Advanced topics in group theory. Possible topics include cohomolgy of groups, locally finite groups, character theory, modular representation theory, representation theory of symmetric and classical groups, finite simple groups, geometric group theory.
Prerequisites: MATH 6310 with a minimum grade of D- or MATH 8310 with a minimum grade of D-

MATH 8400 Topology I
[3 credit hours]
Topological spaces, continuous functions, compactness, product spaces, Tychonov's theorem, quotient spaces, local compactness, homotopy theory, the fundamental group, covering spaces.
Prerequisites: MATH 7450 with a minimum grade of D- or MATH 4450 with a minimum grade of D- or MATH 5450 with a minimum grade of D-
Term Offered: Fall

MATH 8410 Topology II
[3 credit hours]
Homology theory, excision, homological algebra, the Brouwer fixed point theorem, cohomology, differential manifolds, orientation, tangent bundles, Sard' theorem, degree theory.
Prerequisites: MATH 6400 with a minimum grade of D- or MATH 8400 with a minimum grade of D-
Term Offered: Spring

MATH 8440 Differential Geometry I
[3 credit hours]
Introduction to differential geometry. Topics include differentiable manifolds, vector fields, tensor bundles, the Frobenius theorem, Stokes' theorem, Lie groups.
Prerequisites: MATH 6410 with a minimum grade of D- or MATH 8410 with a minimum grade of D-
Term Offered: Fall

MATH 8450 Differential Geometry II
[3 credit hours]
Topics include connections on manifolds, Riemannian geometry, the Gauss-Bonnet theorem. Further topics may include: homogeneous and symmetric spaces, minimal surfaces. Morse theory, comparison theory, vector and principal bundles.
Prerequisites: MATH 6440 with a minimum grade of D- or MATH 8440 with a minimum grade of D-
Term Offered: Spring

MATH 8500 Ordinary Differential Equations
[3 credit hours]
Existence, uniqueness and dependence on initial conditions and parameter, nonlinear planar systems, linear systems, Floquet theory, second order equations, Sturm-Liouville theory.
Term Offered: Fall

MATH 8510 Partial Differential Equations
[3 credit hours]
First order quasi-linear systems of partial differential equations, boundary value problems for the heat and wave equation, Dirichlet problem for Laplace equation, fundamental solutions for Laplace, heat and wave equations.
Term Offered: Spring

MATH 8520 Dynamical Systems I
[3 credit hours]
Topic include the flow-box theorem, Poincare maps, attractors, w-limit sets, Lyapunov stability, invariant submanifolds, Hamiltonian systems and symplectic manifolds.
Prerequisites: MATH 6500 with a minimum grade of D- or MATH 8500 with a minimum grade of D-

MATH 8530 Dynamical Systems II
[3 credit hours]
Topics may include local bifurcations of vector fields, global stability, ergodic theorems, integrable systems, symbolic dynamics, chaos theory.
Prerequisites: MATH 6520 with a minimum grade of D- or MATH 8520 with a minimum grade of D-

MATH 8540 Partial Differential Equations I
[3 credit hours]
Possible topics may include: the Cauchy-Kovalevskaya Theorem, nonlinear partial differential equations of the first order, theory of Sobolev spaces, linear second order PDE's of elliptic, hyperbolic and parabolic type.
Prerequisites: MATH 6510 with a minimum grade of D- or MATH 8510 with a minimum grade of D-
Term Offered: Fall

MATH 8550 Partial Differential Equations II
[3 credit hours]
Selected topics in Partial Differential Equations of current interest emphasizing nonlinear theory. Possible topics may include: Minimal surfaces, applications of the Hopf maximum principle, free boundary value problems, harmonic maps, geometric evolution equations and the Navier-Stokes equation.
Prerequisites: MATH 6540 with a minimum grade of D- or MATH 8540 with a minimum grade of D-
Term Offered: Spring

MATH 8600 Statistical Consulting
[1-5 credit hours]
Real data applications of various statistical methods, project design and analysis including statistical consulting experience. May be repeated for credit.
Term Offered: Spring, Fall

MATH 8610 Statistical Consulting II
[2 credit hours]
Real data applications of various statistical methods, project design and analysis including statistical consulting experience.
Term Offered: Spring

MATH 8620 Categorical Data Analysis
[3 credit hours]
Important methods and modeling techniques using generalized linear models and emphasizing loglinear and logit modeling.
Prerequisites: MATH 5680 with a minimum grade of D- or MATH 7680 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 8630 Nonparametric Statistics
[3 credit hours]
Statistical methods based on counts and ranks; methods designed to be effective in the presence of contaminated data or error distribution misspecification.
Prerequisites: MATH 5680 with a minimum grade of C- or MATH 7680 with a minimum grade of C-
Term Offered: Spring, Fall

MATH 8640 Topics In Statistics
[3 credit hours]
Topics selected from an array of modern statistical methods such as survival analysis, nonlinear regression, Monte Carlo methods, etc.
Term Offered: Spring, Fall

MATH 8650 Statistical Inference
[3 credit hours]
Estimation, hypothesis testing, prediction, sufficient statistics, theory of estimation and hypothesis testing, simultaneous inference, decision theoretic models.
Prerequisites: MATH 5680 with a minimum grade of D- or MATH 7680 with a minimum grade of D-
Term Offered: Fall

MATH 8670 Measure Theoretic Probability
[3 credit hours]
Real analysis, probability spaces and measures, random variables and distribution functions, independence, expectation, law of large numbers, central limit theorem, zero-one laws, characteristic functions, conditional expectations given a s-algebra, martingales.
Prerequisites: MATH 5680 with a minimum grade of D- or MATH 7680 with a minimum grade of D-
Term Offered: Fall

MATH 8680 Theory Of Statistics
[3 credit hours]
Exponential families, sufficiency, completeness, optimality, equivariance, efficiency. Bayesian and minimax estimation. Unbiased and invariant tests, uniformly most powerful tests. Asymptotic properties for estimation and testing. Most accurate confidence intervals.
Term Offered: Spring

MATH 8690 Multivariate Statistics
[3 credit hours]
Multivariate normal sampling distributions, T tests and MANOVA, tests on covariance matrices, simultaneous inference, discriminant analysis, principal components, cluster analysis and factor analysis.
Prerequisites: MATH 5690 with a minimum grade of D- or MATH 6650 with a minimum grade of D- or MATH 8650 with a minimum grade of D-
Term Offered: Spring

MATH 8720 Methods Of Mathematical Physics I
[3 credit hours]
Analytic functions, residues, method of steepest descent, complex differential equations, regular singularities, integral representation, real and complex vector spaces, matrix groups, Hilbert spaces, coordinate transformations.
Term Offered: Fall

MATH 8730 Methods Of Mathematical Physics II
[3 credit hours]
Self-adjoint operators, special functions, orthogonal polynomials, partial differential equations and separation of variables, boundary value problems, Green¿s functions, integral equations, tensor analysis, metrics and curvature, calculus of variations, finite groups and group representations.
Prerequisites: MATH 6720 with a minimum grade of D- or MATH 8720 with a minimum grade of D-

MATH 8800 Real Analysis I
[3 credit hours]
Completeness, connectedness and compactness in metric spaces, continuity and convergence, Stone-Weierstrass Theorem, Lebesgue measure and integration on the real line, convergence theorems, Egorov's and Lusin's theorems, derivatives, functions of bounded variation.
Prerequisites: MATH 7830 with a minimum grade of D- or MATH 4830 with a minimum grade of D- or MATH 5830 with a minimum grade of D-
Term Offered: Fall

MATH 8810 Real Analysis II
[3 credit hours]
The Vitali covering theorem, absolutely continuous functions, Lebesgue-Stieltjes integration, the Reisz representation theorem, Banach spaces, Lp-spaces, abstract measures, the Radon-Nikodym theorem, measures on locally compact Hausdorff spaces.
Prerequisites: MATH 6800 with a minimum grade of D- or MATH 8800 with a minimum grade of D-
Term Offered: Spring

MATH 8820 Functional Analysis I
[3 credit hours]
Topics include Topological vector spaces, Banach spaces, convexity, the Hahn-Banach theorem, weak and strong topologies, Lp spaces and duality.
Prerequisites: MATH 6810 with a minimum grade of D- or MATH 8810 with a minimum grade of D-
Term Offered: Fall

MATH 8830 Functional Analysis II
[3 credit hours]
Topics include the Mackey-Ahrens Theorem, Banach algebras, spectra in Banach algebras, commutative Banach algebras, unbounded operators, the spectral theorem, topics in functional analysis.
Prerequisites: MATH 6820 with a minimum grade of D- or MATH 8820 with a minimum grade of D-
Term Offered: Spring, Fall

MATH 8840 Complex Analysis I
[3 credit hours]
Elementary analytic functions, complex integration, the residue theorem, infinite sequences of analytic functions, Laurent expansions, entire functions.
Prerequisites: MATH 6800 with a minimum grade of D- or MATH 8800 with a minimum grade of D-
Term Offered: Fall

MATH 8850 Complex Analysis II
[3 credit hours]
Meromorphic functions, conformal mapping, harmonic functions and the Dirichlet problem, the Riemann mapping theorem, monodromy, algebraic functions, Riemann surfaces, elliptic functions and the modular function.
Prerequisites: MATH 6840 with a minimum grade of D- or MATH 8840 with a minimum grade of D-
Term Offered: Spring

MATH 8860 Nonlinear Analysis I
[3 credit hours]
Topological Degree in Banach Spaces (Schuder fixed point theorem and Leray-Schauder theory) , non-resonance and topological degree, Lazer-Leach conditions and variations, variational techniques including Ekeland principle and its applications and Mountain Pass theorem, resonance and periodic solutions, Lusternik-Schnirelmann Theory, Poincare'-Birkhoff Theorem. Bifurcation theory: Morse lemma and its applications. Rabinowitz theorem and Krasnoselski theorem and its applications. Stability of solutions and number of global solutions to a nonlinear problem.
Prerequisites: MATH 8500 with a minimum grade of D- and MATH 8510 with a minimum grade of D-
Term Offered: Fall

MATH 8870 Measure Theoretic Probability II
[3 credit hours]
Focus on stochastic processes.Conditional expectations, martingales, random walks, markov chains, ergodic theorem, brownian motion.
Prerequisites: MATH 5680 with a minimum grade of D- and MATH 6860 with a minimum grade of D- and MATH 8860 with a minimum grade of D-
Corequisites: MATH 6800

MATH 8880 Nonlinear Analysis II
[3 credit hours]
The instructor based in his/her interests and on the interests and needs of the students attending the course will select a subset among the following topics: Geometric singular perturbation theory Further topological methods: extensions of Leray-Schauder degree and applications to partial differential equations. Framed cobordism and stable cohomotopy theorem. Applications to existence of global solutions. Monotone operators and mini-max theorem. Generalized implicit function theorems, KAM and Conjugacy problems. Critical Points Theory and Hamiltonian Systems.
Prerequisites: MATH 8500 with a minimum grade of D- and MATH 8510 with a minimum grade of D- and MATH 8870 with a minimum grade of D-
Term Offered: Spring

MATH 8890 Problems In Algebra, Topology, And Analysis
[1 credit hour]
Practicum in solving problems in graduate algebra, topology and analysis. Supplements 6300-10, 6400-10 and 6800-10 and prepares students for doctoral qualifying examination.

MATH 8930 Colloquium
[1 credit hour]
Lectures by visiting mathematicians and staff members on areas of current interest in mathematics.
Term Offered: Spring, Fall

MATH 8940 Proseminar
[1-5 credit hours]
Problems and techniques of teaching elementary college mathematics, supervised teaching, seminar in preparation methods.
Term Offered: Spring, Fall

MATH 8960 Dissertation
[1-6 credit hours]
Student works toward their dissertation.
Term Offered: Spring, Summer, Fall

MATH 8980 Topics In Mathematical Sciences
[3 credit hours]
Special topics in Mathematics or Statistics.
Term Offered: Spring, Summer, Fall

MATH 8990 Readings In Mathematics
[1-5 credit hours]
Readings in areas of Mathematics of mutual interest to the student and the professor.
Term Offered: Spring, Summer, Fall