

MASTER OF SCIENCE IN MATHEMATICS

Program Description

The Department of Mathematics and Statistics offers the M.S. degree in Mathematics both traditionally and online. Options for this degree include:

- predoctoral studies,
- applied mathematics,
- computer science,
- secondary mathematics,
- statistics, and
- actuarial science.

Graduate faculty members have a broad range of research interests in both pure and applied areas. The curriculum stresses theoretical as well as computational mathematics and is flexible enough to key a student's program to individual interests and abilities. Receiving a well-rounded education in mathematics, graduates can pursue a Ph.D., secure a position in government or industry, or further a teaching career.

The Department of Mathematics and Statistics also offers a Master of Science in Data Science and Statistics, a Graduate Certificate in Mathematics, and a Graduate Certificate in Data Analytics.

Program Director

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Admission Requirements

In addition to the minimum Graduate Studies admission requirements, students must also have the following:

COURSE	TITLE	S.H.
A cumulative undergraduate grade point average of at least 3.0 (on a 4.0 scale) in all undergraduate mathematics and statistics courses.		
A completed sequence in standard calculus comparable to:		
MATH 1571	Calculus 1	4
MATH 1572	Calculus 2	4
MATH 2673	Calculus 3	4
Previous courses in discrete structures and linear algebra comparable to:		
MATH 3715	Discrete Mathematics	3
MATH 3720	Linear Algebra and Matrix Theory	3
Previous courses in abstract algebra and real analysis comparable to:		
MATH 5821	Topics in Abstract Algebra	4
MATH 5851	Topics in Analysis	4

Students not satisfying all of the above may be admitted with provisional status subject to the approval of the graduate program director and graduate studies. Students may need to complete prerequisite examinations to demonstrate readiness for the core courses. If students do not pass the prerequisite examination, students must complete the prerequisite courses in the earliest available semester. The prerequisite courses are not included in the 30-semester hour minimum requirement.

- Students entering without a prior course in abstract algebra must include MATH 5821 Topics in Abstract Algebra in their program, to be taken in the earliest available semester, and students entering without a prior course in theoretical analysis must include MATH 5851 Topics in Analysis in their

program, to be taken in the earliest available semester. Students may need to complete prerequisite examinations in algebra and/or analysis to demonstrate readiness for the core courses. If students do not pass the prerequisite examination, students must complete the prerequisite courses in the earliest available semester. These courses are not included in the 30-semester-hour minimum requirement.

- A minimum of 30 semester hours of credit excluding MATH 5821 Topics in Abstract Algebra and MATH 5851 Topics in Analysis
- A cumulative grade point average of at least 3.0.
- The student's combined undergraduate and graduate programs must include a mathematics core comprising the following courses or their equivalent:

COURSE	TITLE	S.H.
MATH 5821	Topics in Abstract Algebra (if needed, taken in the earliest available semester (Does not count toward master's degree))	
MATH 5851	Topics in Analysis (if needed, taken in the earliest available semester (Does not count toward master's degree))	
MATH 6926	Advanced Linear Algebra	3
MATH 6947	Methods of Applied Mathematics	3
MATH 6952	Analysis of Real Variable Functions	3
Choose one of the following:		3
MATH 6996	Mathematical Project	
	or STEM 6998STEM Graduate Internships	
18 Hours of Electives in MATH/STAT/DATX at the 5800 or higher with at least one course at the 6900-level.		18
Total Semester Hours		30

- Before completing 12 semester hours, the student must submit the entire degree program for approval and evaluation by the Graduate Executive Committee in the Department of Mathematics and Statistics. At least 15 hours of the student's approved program must be at the 6900 level. Subsequent revisions to this program must be approved by the Graduate Executive Committee.
- MATH 6999 Thesis is highly recommended. An abstract of a proposed thesis must be submitted for approval prior to registering for the course.
- Satisfactory performance on two oral examinations of graduate coursework in addition to presentation of project, internship presentation, or defense of thesis. The subject matter for the oral examinations must be approved by the Graduate Executive Committee.

Students with particular interests or career goals are advised to choose elective courses based upon the recommendations below.

Predocutorial Studies in Mathematics and/or Applied Mathematics

COURSE	TITLE	S.H.
MATH 6922	Advanced Topics in Group and Ring Theory	3
MATH 6975	Complex Analysis 1	3
MATH 6980	Topology 1	3
STAT 6940	Advanced Data Analysis	3
MATH 6955	Advanced Differential Equations	3
STAT 6943	Mathematical Statistics 1	3

Statistics

COURSE	TITLE	S.H.
STAT 6940	Advanced Data Analysis	3
STAT 6948	Linear Models	3

STAT 6943	Mathematical Statistics 1	3
STAT 6944	Mathematical Statistics 2	3

Actuarial Science

COURSE	TITLE	S.H.
STAT 5802	Mathematical Interest Theory	3
STAT 6943	Mathematical Statistics 1	3
STAT 6944	Mathematical Statistics 2	3

Applied Mathematics

COURSE	TITLE	S.H.
MATH 5860	Numerical Analysis 1	3
MATH 6955	Advanced Differential Equations	3
MATH 6957	Partial Differential Equations	3
STAT 6940	Advanced Data Analysis	3
STAT 6943	Mathematical Statistics 1	3

Secondary/Community College Mathematics

COURSE	TITLE	S.H.
STAT 6943	Mathematical Statistics 1	3
STAT 6940	Advanced Data Analysis	3
MATH 6922	Advanced Topics in Group and Ring Theory	3
MATH 6975	Complex Analysis 1	3
MATH 6980	Topology 1	3

Those students seeking certification should consult an advisor in the Department of Teacher Education and Leadership Studies.

Computer Science

Students in coursework in computer science in addition to mathematics should plan their graduate program in consultation with advisors in both the Department of Mathematics and Statistics and the School of Computer Science, Information and Engineering Technology.

4+1 Bachelor's/Master's Program

Undergraduate students can apply for admission into the 4+1 program for the MS in Mathematics after completing 78 undergraduate semester hours with a GPA of 3.3 or higher. After being admitted into the program, students can take a maximum of nine semester hours of graduate coursework that can count toward both a bachelor's and master's degree from the Department of Mathematics and Statistics. The courses chosen to count for both undergraduate and graduate coursework must be approved by the Graduate Executive Committee within the Department upon admission into the program. An additional three hours of graduate coursework can be completed as an undergraduate and used exclusively for graduate credit.

Learning Outcomes

Students will develop and demonstrate the ability to reason mathematically by constructing mathematical proofs and recognizing and analyzing accurate numerical data in appropriate core courses. Students will learn that truth in mathematics is verified by careful argument, and will demonstrate the ability to make conjectures and form hypotheses, test the accuracy of their work, and effectively solve problems.

Students will learn to identify fundamental concepts of mathematics as applied to science and other areas of mathematics, and to interconnect the roles of pure and applied mathematics.

Students will demonstrate that they can communicate mathematical ideas effectively, both orally and in writing, by completing a graduate project or thesis involving an investigative mathematical project, together with oral and written examinations.

Students in cooperative doctoral programs will demonstrate their ability to create significant, original mathematics.

Graduate Faculty

Jozsi Z. Jalics, Ph.D., Professor

Computational neuroscience; mathematical biology; dynamical systems; partial differential equations

G. Jay Kerns, Ph.D., Professor

Signed measures; infinite divisibility; exchangeability in probability and statistics; applications of stochastic processes

Lucy Xiaojing Kerns, Ph.D., Professor

Simultaneous confidence bands; minimum effective doses; benchmark dose methodology

Thomas L. Madsen, Ph.D., Associate Professor

Abstract algebra; group theory; representation theory

Nguyet Thi Nguyen, Ph.D., Associate Professor

Financial models; Monte Carlo simulation; actuarial science

Alicia Prieto Langarica, Ph.D., Professor

Mathematical biology; agent-based modeling

Thomas Smotzer, Ph.D., Professor

Real analysis; measure theory; operator theory

Jamal K. Tartir, Ph.D., Professor

Set-theoretic topology

Padraic ("Paddy") W. Taylor, Ph.D., Associate Professor

Multipoint Boundary Value Problems

Thomas P. Wakefield, Ph.D., Professor, Chair

Character theory; actuarial science

Graduate Courses

MATH 5821 Topics in Abstract Algebra 4 s.h.

A course in abstract algebra aimed at developing a broad understanding of the subject. Credit will not be given for both MATH 3721 and MATH 5821.

Prereq.: Permission of graduate director or department chair required.

MATH 5828 Number Theory 3 s.h.

A study of congruences, Diophantine equations, quadratic residues, special number theory functions, and selected applications.

Prereq.: MATH 3721.

MATH 5835 Introduction to Combinatorics and Graph Theory 3 s.h.

The pigeonhole principle; permutations, combinations, the binomial theorem; the inclusion-exclusion principle; recurrence relations; graphs and digraphs, paths and cycles, trees, bipartite graphs and matchings.

Prereq.: C or better in either MATH 3715 or CSCI 3710 and C or better in MATH 3720.

MATH 5845 Operations Research 3 s.h.

An introduction to operations research with emphasis on mathematical methods. Topics may include: linear programming, sensitivity analysis, duality theory, transportation problems, assignment problems, transshipment problems, and network problems.

Prereq.: MATH 3715 and MATH 3720.

MATH 5849 Computational Methods for Problems in the Physical Sciences 3 s.h.

Use of contemporary computational approaches to conduct research in the physical sciences using Matlab and supercomputers. Algorithm development and formal exercise tasks may vary depending on the stage of the course, student abilities, and the topic under consideration. Provides application of the techniques discussed in the class to real world situations.

Prereq.: MATH 3705 and PHYS 2610.

Cross-Listed: CSCI 5849 and PHYS 5849.

MATH 5851 Topics in Analysis 4 s.h.

A course in analysis aimed at developing a broad understanding of the subject. Credit will not be given for both MATH 3751 and MATH 5851.

Prereq.: Permission of graduate director or department chair required.

MATH 5860 Numerical Analysis 1 3 s.h.

The theory and techniques of numerical computation. The solution of a single equation, interpolation methods, numerical differentiation and integration, direct methods for solving linear systems.

Prereq.: MATH 3720 and CSIS 2610 and MATH 2673, MATH 2673H, or MATH 2686H.

MATH 5861 Numerical Analysis 2 3 s.h.

Numerical methods of initial-value problems, eigenvalue problems, iterative methods for linear and nonlinear systems of equations, and methods involving least squares, orthogonal polynomials, and fast Fourier transforms.

Prereq.: MATH 5860 or equivalent.

MATH 5895 Selected Topics in Mathematics 1-4 s.h.

The study of a standard mathematical topic in depth or the development of a special area of mathematics. May be repeated twice.

Prereq.: Permission of the instructor.

MATH 6901 Mathematics Workshop 1-6 s.h.

Intensive study and activity in a topic related to mathematics, its applications, or the teaching of mathematics. May be repeated. Grading is S/U.

Prereq.: Permission of graduate director.

MATH 6905 College Teaching of Mathematics 1 s.h.

Intensive preparation for teaching introductory mathematics and statistics courses, featuring formal instruction and orientation on teaching issues, evaluated presentations, mentored classroom instruction, and weekly teaching seminars. Topics include course design, policies, syllabi, grading, classroom teaching issues, and best practices in mathematics and statistics education at the postsecondary level. Required of graduate assistants in the Department of Mathematics and Statistics and to be taken each semester the student is a graduate assistant. Grading is S/U. Does not count toward credit in the program.

MATH 6910 Advanced Engineering Mathematics 1 3 s.h.

Theory and solution techniques used in engineering applications. Topics include brief review of ordinary differential equations and linear algebra; vector calculus, integral theorems, complex analysis, series, residue theory, potential theory, special functions, integral transforms, partial differential equations and applications in mathematical modeling.

Prereq.: MATH 3705.

MATH 6910R Corequisite Support for Advanced Engineering Mathematics 1 1 s.h.

This course is intended to provide corequisite support for students concurrently enrolled in MATH 6910 (Advanced Engineering Mathematics).

Emphasis will be placed on a just-in-time review of topics in calculus, differential equations, linear algebra, and logic to facilitate a smoother transition to graduate level mathematics. Students who are a few years removed from a differential equations course are especially encouraged to enroll. Grading is S/U. Does not count for graduate credit.

Prereq.: MATH 3705.

Coreq.: MATH 6910.

MATH 6911 Advanced Engineering Mathematics 2 3 s.h.

Theory and solution techniques used in engineering applications. Topics include brief review of ordinary differential equations and linear algebra; vector calculus, integral theorems, complex analysis, series, residue theory, potential theory, special functions, integral transforms, partial differential equations and applications in mathematical modeling.

Prereq.: MATH 6910.

MATH 6911R Corequisite Support for Advanced Engineering Mathematics 2 1 s.h.

This course is intended to provide corequisite support for students concurrently enrolled in MATH 6911 (Advanced Engineering Mathematics 2). Emphasis will be placed on a just-in-time review of topics in vector calculus, Fourier series, partial differential equations, and complex analysis. Grading is S/U. Does not count for graduate credit.

Prereq.: MATH 6910.

Coreq.: MATH 6911.

MATH 6915 Mathematical Foundations 3 s.h.

Order-theoretic and monadic foundations of mathematics: ordered structures; topologies; powerset operators of a function; applications to continuity, compactness, algebra, logic, and calculus.

Prereq.: MATH 3721 Abstract Algebra I and MATH 3751 Real Analysis I, or permission of graduate director.

MATH 6922 Advanced Topics in Group and Ring Theory 3 s.h.

A continuation of MATH 5821 with special emphasis on groups acting on sets, Sylow's Theorem and its applications, ring homomorphisms, ideals, and polynomial rings. Credit will not be given for MATH 4822 and MATH 6922.

Prereq.: MATH 3721 or MATH 5821.

MATH 6923 Advanced Topics in Field Theory 3 s.h.

This course introduces the major results in advanced field theory. These results include splitting fields, algebraic extensions, finite extensions, cyclotomic polynomials, and finite fields. Credit will not be given for MATH 4823 and MATH 6923.

Prereq.: MATH 4822 or MATH 6922.

MATH 6926 Advanced Linear Algebra 3 s.h.

This advanced linear algebra course will include a study of abstract vector spaces and linear transformations, among other topics. Applications of linear algebra may be included.

Prereq.: MATH 3721 or MATH 5821 or satisfactory score on a Departmental prerequisite examination.

MATH 6936 Advanced Topics and Research in Graph Theory 3 s.h.

This is a research-based course in graph theory that builds upon knowledge learned in MATH 5835. The research process of a mathematician will be introduced and exercised while exploring advanced topics in graph theory and making discoveries through independent research.

Prereq.: MATH 5835.

MATH 6947 Methods of Applied Mathematics 3 s.h.

This course surveys topics in applied mathematics and may include scaling, perturbation methods, stationary phase analysis, multi-scale asymptotics, transform methods, Green's functions, discrete models, the calculus of variations, or optimization.

Prereq.: Graduate Standing.

MATH 6952 Analysis of Real Variable Functions 3 s.h.

This course covers topics in the analysis of functions, mainly of several variables, and may include uniform convergence of sequences of functions and some consequences, functions on n -space, derivatives in vector spaces, and results such as the mean value theorem, Taylor's formula, inverse mapping theorem, and the implicit mapping theorem.

Prereq.: MATH 3751 or MATH 5851 or satisfactory score on a Departmental prerequisite examination.

MATH 6955 Advanced Differential Equations 3 s.h.

Proofs of existence and uniqueness of nonautonomous, nonlinear equations. Additional topics may include advanced linear systems, partial differential equations, and integral equations.

Prereq.: MATH 3720 and MATH 3705 or permission of graduate director.

MATH 6957 Partial Differential Equations 3 s.h.

An introduction to partial differential equations (PDE) and their applications. The classification of the basic types of linear partial differential equations, development of how boundary and initial conditions affect solutions, exploration, and application of solution techniques for PDEs and explosions in orthogonal functions will be presented.

Prereq.: MATH 3705 and MATH 3720 or equivalent .

MATH 6975 Complex Analysis 1 3 s.h.

Analytic and meromorphic functions of a complex variable, contour integration, the Cauchy-Goursat theorem, Taylor and Laurent series, residues and poles, conformal mapping. Credit will not be given for both MATH 4875 and MATH 6975.

Prereq.: MATH 3751 Real Analysis I, or permission of graduate director.

MATH 6980 Topology 1 3 s.h.

Basic concepts of topological spaces and mappings between them, including compactness, connectedness, and continuity. Credit will not be given for both MATH 4880 and MATH 6980.

Prereq.: MATH 3721 Abstract Algebra I and MATH 3751 Real Analysis I, or permission of graduate director.

MATH 6981 Topology 2 3 s.h.

Separation, metrization, compactification. Additional topics will be selected from point-set topology, fuzzy topology, algebraic topology, combinatorial topology, topological algebra.

Prereq.: MATH 4880 or MATH 6980, or permission of graduate director.

MATH 6990 Independent Study 1-3 s.h.

Study under the supervision of a staff member. May be repeated. 3 s.h.

Prereq.: Approval of graduate director.

MATH 6995 Special Topics 1-3 s.h.

Specialized topics selected by the staff. May be repeated up to 12 semester hours.

Prereq.: Permission of graduate director and department chair.

MATH 6996 Mathematical Project 1-3 s.h.

Individual research project culminating in a written report or paper, though not as broad in scope as a thesis. May be repeated once if the second project is in a different area of mathematics.

MATH 6999 Thesis 3 s.h.

A student may register for six semester hours in one semester or for three semester hours in each of two semesters.

MATH 7005 Advanced Topics in Categorical Topology 3 s.h.

Content varies with each offering. Implements ideas from MATH 6915, MATH 6980, MATH 6981, and studies categorical methods in topology and related concrete categories. Emphasis on current literature and open questions. May be repeated with approval of graduate director.

Prereq.: MATH 6915, MATH 6980, MATH 6981, or equivalent, or permission of the graduate director.

MATH 7015 Advanced Topics in Foundations of Topology 3 s.h.

Content varies with each offering, implements ideas from MATH 6915, MATH 6980, MATH 6981, and studies foundations of topology from a variety of viewpoints (algebraic, categorical, logical, order theoretic, powerset theoretic, set theoretic, etc.). Emphasis on current literature and open questions. May be repeated with approval of graduate director.

Prereq.: MATH 6915, MATH 6980, MATH 6981, or equivalent, or permission of graduate director.

MATH 7025 Advanced Topics in General Topology 3 s.h.

Content varies with each offering, implements ideas from MATH 6915, MATH 6980, MATH 6981, and studies various topics in point-set topology. Emphasis on current literature and open questions. May be repeated with approval of graduate director.

Prereq.: MATH 6980, MATH 6981, or equivalent, or permission of graduate director.

MATH 7035 Advanced Topics in Lattice-Valued Topology 3 s.h.

Content varies with each offering. Implements ideas from MATH 6915, MATH 6980, MATH 6981, and studies topology from the standpoint of lattice-valued (fuzzy) subsets. Emphasis on current literature and open questions. May be repeated with approval of graduate director.

Prereq.: MATH 6915, MATH 6980, MATH 6981, or equivalent, or permission of the graduate director.

MATH 7045 Advanced Topics in Topological Analysis 3 s.h.

Content varies with each offering. Implements ideas from MATH 6915, MATH 6980, MATH 6981, and studies the overlap between topology and abstract analysis (topological games, topological groups, separate versus joint continuity, etc.). Emphasis on current literature and open questions. May be repeated with approval of graduate director.

Prereq.: MATH 6915, MATH 6980, MATH 6981, or equivalent, or permission of graduate director.

MATH 7055 Seminar in Topology and Abstract Analysis 3 s.h.

Content varies with each offering. Implements ideas from MATH 6915, MATH 6980, MATH 6981, and focuses on current research activities of seminar participants. Student registrants are expected to make at least one major presentation each month of the term. May be repeated with approval of graduate director.

Prereq.: Permission of graduate director.