MASTER OF SCIENCE IN MATHEMATICS

Program Director

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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 Graduate Certificate in Mathematics and a Graduate Certificate in Data Analytics

Admission Requirements

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

COURSE	TITLE	S.H.
A cumulative undergraduate cumulative grade point average of at least 3.0 (on a 4.0 scale) in all undergraduate mathematics an 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
The Graduate Record Examination		

GRE requirement may be waived for students who have completed at least 9 hours of graduate coursework with an average GPA of 3.0

Students not satisfying all of the above may be admitted with provisional status subject to the approval of the graduate program director and the graduate dean.

Graduate Faculty

Alexis Byers, Ph.D., Assistant Professor
Graph Theory

Guang-Hwa (Andy) Chang, Ph.D., Professor
Biostatistics

Neil Flowers, Ph.D., Assistant Professor
Solvable groups; classification problems in group theory

Richard G. Goldthwait, Ph.D., Assistant Professor
Math education

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., Associate 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

Anita C. O'Mellan, Ph.D., Professor
Graph theory; combinatorics; early childhood mathematics education

Alicia Prieto Langarica, Ph.D., Professor
Mathematical biology; agent-based modeling

Stephen Rodabaugh, Ph.D., Professor
Foundations of topology and fuzzy logic: point-set, lattice-theoretic, and categorical methods

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

Eric J. Wingler, Ph.D., Professor
Real analysis; complex analysis; operator theory

- A minimum of 33 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
- 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. These courses are not included in the 33-semester-hour minimum requirement.
- 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 (taken in the earliest available semester)	4
MATH 5851	Topics in Analysis (taken in the earliest available semester)	4
MATH 5825	Advanced Linear Algebra	3

MATH 5852	Real Analysis 2	3
MATH 6996	Mathematical Project	1-3

- Satisfactory performance on written and oral examinations. The subject matter for these examinations must be approved by the Graduate Executive Committee. Additionally, the following distribution requirements apply:
  - Written exams in MATH 5852, Math 5825 and the first course in the student's chosen course sequence
  - Oral exam on thesis, or oral exam on a project and two courses
  - At least half of the hours of the courses examined must be at the 6900 level
- At least 17 hours of the student's approved program must be at the 6900 level. In addition to completing the courses which make up the mathematics core, students must complete at least one course sequence for depth and at least fifteen additional hours of elective courses to satisfy the breadth requirement for the degree. The course groupings are described below.
- MATH 6999 Thesis is highly recommended
- 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. Subsequent revisions to this program must be approved by the Graduate Executive Committee. An abstract of a proposed thesis must be submitted for approval prior to registering for the course.
- Students must participate in an exit interview during the semester in which they plan on graduating. The exit interview will be conducted with one or more members of the Graduate Executive Committee and must be scheduled by the student prior to the thesis or project presentation.

Course Sequences for Depth

The description of the recommended course sequences for depth will refer to the following list. The sequences offered depend upon student interest.

COURSE	TITLE	S.H.
Abstract Algebra		
MATH 6922	Advanced Topics in Group and Ring Theory	3
MATH 6923	Advanced Topics in Field Theory	3
Actuarial Mathematics		
STAT 6988	Modeling in Financial Economics	3
STAT 5802	Theory of Interest	3
Advanced Data Analysis		
STAT 6940	Advanced Data Analysis	3
STAT 6948	Linear Models	3
Differential Equations		
MATH 6955	Advanced Differential Equations	3
MATH 6957	Partial Differential Equations	3
Mathematical Statistics		
STAT 6943	Mathematical Statistics 1	3
STAT 6944	Mathematical Statistics 2	3
Numerical Analysis		
MATH 5860	Numerical Analysis 1	3
MATH 5861	Numerical Analysis 2	3
Operations Research		
MATH 5845	Operations Research	3
MATH 6942	Advanced Operations Research	3
Topology		
MATH 6980	Topology 1	3
MATH 6981	Topology 2	3

Predoctoral Studies in Mathematics and Applied Mathematics

COURSE	TITLE	S.H.
MATH 6922	Advanced Topics in Group and Ring Theory	3
MATH 6923	Advanced Topics in Field Theory	3
MATH 6975	Complex Analysis 1	3
MATH 5852	Real Analysis 2	3
MATH 6980	Topology 1	3
STAT 6940	Advanced Data Analysis	3
MATH 6955	Advanced Differential Equations	3
STAT 6943	Mathematical Statistics 1	3
MATH 5861	Numerical Analysis 2	3
MATH 5845	Operations Research	3
Electives		
Select two or more sequences in areas of interest		

Statistics

COURSE	TITLE	S.H.
Core Requirements		
STAT 6940	Advanced Data Analysis	3
STAT 6948	Linear Models	3
STAT 6943	Mathematical Statistics 1	3
STAT 6944	Mathematical Statistics 2	3
Electives		
Select 9 additional hours of statistics courses.		9

Actuarial Science

COURSE	TITLE	S.H.
Core Requirements		
STAT 5802	Theory of Interest	3
STAT 6943	Mathematical Statistics 1	3
STAT 6944	Mathematical Statistics 2	3
Electives		
Select from statistics and actuarial science course offerings		

Applied Mathematics

COURSE	TITLE	S.H.
Core Requirements		
STAT 6940	Advanced Data Analysis	3
MATH 6955	Advanced Differential Equations	3
STAT 6943	Mathematical Statistics 1	3
MATH 5861	Numerical Analysis 2	3
MATH 5845	Operations Research	3
Depth Requirement		
Select the second course in one of the sequences		

Secondary/Community College Mathematics

COURSE	TITLE	S.H.
STAT 6943	Mathematical Statistics 1	3
or		
STAT 6940	Advanced Data Analysis	3
Select one of the following:		3
MATH 6915	Mathematical Foundations	3
MATH 6922	Advanced Topics in Group and Ring Theory	3
MATH 6923	Advanced Topics in Field Theory	3
MATH 6975	Complex Analysis 1	3

| MATH 6965 | Abstract Analysis 1 | 3 |
| MATH 6980 | Topology 1 | 3 |

Those students seeking certification should consult an advisor in the school of Education.

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 Department of Computer Science and Information Systems.

Accelerated MS Mathematics

Undergraduate students can apply for admission into the accelerated program for the MS in Mathematics after completing 78 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 an 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 six 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 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.: MATH 3715 and MATH 3720.

MATH 5825   Advanced Linear Algebra   3 s.h.
A study of abstract vector spaces, linear transformations, duality, canonical forms, the spectral theorem, and inner product spaces.
Prereq.: MATH 3721.

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 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.: MATH 2673 or MATH 2686H and MATH 3720 and MATH 3715.

MATH 5852   Real Analysis 2   3 s.h.
Uniform convergence of sequences of functions and some consequences; functions on n-space: derivatives in vector spaces, mean value theorem, Taylor's formula, inverse mapping theorem, implicit mapping theorem.
Prereq.: MATH 3720 and MATH 3751 or equivalent.

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, 2673H, or 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 5875   Complex Variables   3 s.h.
Complex numbers and their geometric representation, analytic functions of a complex variable, contour integration, Taylor and Laurent series, residues and poles, conformal mapping.
Prereq.: MATH 3751 or equivalent.

MATH 5895   Selected Topics in Mathematics   2-3 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.: 24 s.h. of mathematics applicable to the mathematics major including either MATH 3721 or MATH 3751.

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 coordinator.

MATH 6905   College Teaching of Mathematics   1 s.h.
Intensive preparation for teaching lower-level mathematics 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 problems; orientation in Mathematics Assistance Center, specific lower-level mathematics courses, online tutorial services. 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 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 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 coordinator.

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 6924   Galois Theory   3 s.h.
An introduction to Galois Theory with special emphasis on the Galois group, the Fundamental Theorem of Galois Theory, and radical extensions.
Prereq.: MATH 4823 or MATH 6923.

MATH 6928   Advanced Number Theory   3 s.h.
Advanced study of number theory: theory and distribution of primes, computational number theory, and additive number theory.
Prereq.: MATH 5828.

MATH 6930   Differential Geometry   3 s.h.
Classical differential geometry of curves and surfaces, differentiable manifolds with tensors.
Prereq.: MATH 5852.

MATH 6942   Advanced Operations Research   3 s.h.
Topics may include integer programming, advanced linear programming, nonlinear programming, dynamic programming, queuing theory, Markov analysis, game theory, and forecasting models.
Prereq.: MATH 5845 and STAT 3743 Probability and Statistics.

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 5852 and either MATH 3705 or MATH 4855 or permission of graduate coordinator.

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 6965   Abstract Analysis 1   3 s.h.
Lebesgue integration and measure on the real line. General measure theory and functional analysis, including the Radon-Nikodym theorem, the Fubini theorem, the Hahn-Banach theorem, the closed graph and open mapping theorems, and weak topology.
Prereq.: MATH 5852 and either MATH 4880 or MATH 6915 or permission of graduate coordinator.

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 5875 and MATH 6975.
Prereq.: MATH 3751 Real Analysis I, or permission of graduate coordinator.

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 coordinator.

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 coordinator.

MATH 6990   Independent Study   1-3 s.h.
Study under the supervision of a staff member. May be repeated.
Prereq.: Consent of graduate coordinator.

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

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

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

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

MATH 7045   Advanced Topics in Topological Analysis   3 s.h.
Content varies with each offering. Implements ideas from MATH 6915, MATH 6965, MATH 6966, 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 coordinator.
Prereq.: MATH 6915, MATH 6965, MATH 6980, MATH 6981, or equivalent, or permission of graduate coordinator.

MATH 7055   Seminar in Topology and Abstract Analysis   3 s.h.
Content varies with each offering. Implements ideas from MATH 6915,
MATH 6930, MATH 6965, MATH 6980, MATH 6981, MATH 6984, 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 coordinator.
Prereq.: Permission of graduate coordinator.