

DEPARTMENT OF MATHEMATICS

The Department of Mathematics offers Master of Science degrees in Applied Mathematics-Industrial Mathematics, Mathematics, and Mathematics Education.

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Master of Science Degree in Applied Mathematics–Industrial Mathematics

The Master of Science Degree in Applied Mathematics–Industrial Mathematics is designed to provide students the opportunity for advanced training in marketable areas of Applied Mathematics, using research to solve real-world problems in the field of Applied Mathematics, and with preparation for leadership positions in the field. In order to provide students with advanced training in marketable areas, 24 semester credit hours of graduate mathematics courses and 3 semester credit hours of a course in the Colleges of Sciences or Engineering are required. Research exposure to and experience with real-world problems will be provided by enrollment in AIM 6943 Internship and Research Project. This course introduces students to research problems in the field as well as the opportunities to solve a real-life problem in an industrial setting. Students will prepare for leadership positions in the field by taking two courses in communication, leadership, and/or basic business practices.

Program Admission Requirements

To be admitted to the degree program for the M.S. in Applied Mathematics–Industrial Mathematics, applicants must satisfy the University-wide requirements for admission to graduate programs. The applicant must have completed a bachelor's degree in mathematics, science, engineering, or a related field and must have taken Calculus I, Calculus II, Linear Algebra, and an upper-division course in mathematics. The applicant must submit a résumé, scores from the Graduate Record Examination (GRE), and three letters of reference from qualified scientists, mathematicians, or supervisors that can certify their ability to pursue studies in applied mathematics at the Master's level.

Degree Requirements

Degree candidates are required to successfully complete 36 semester credit hours and meet University-wide degree requirements. Students admitted to the program must consult the Graduate Advisor of Record for their individual study plans and get approval before enrollment in each course.

Candidates for the degree must complete:

A. 6 semester credit hours of required courses:	6
AIM 5113 Introduction to Industrial Mathematics	
MAT 5283 Linear Algebra	
B. Select 18 semester credit hours of the following:	18
MAT 5203 Theory of Functions of a Real Variable I	
MAT 5223 Theory of Functions of a Complex Variable I	
MAT 5293 Numerical Linear Algebra	
MAT 5323 Mathematical Modeling	

MAT 5603 Numerical Analysis	
MAT 5613 Numerical Solutions of Differential Equations	
MAT 5653 Differential Equations I	
MAT 5673 Partial Differential Equations I	
MAT 5973 Directed Research	
MAT 5983 Topics in Applied Mathematics	
MAT 6603 Optimization Techniques in Operations Research	
C. 3 semester credit hours of electives: Upon completion of 18 semester credit hours in mathematics, a student is eligible to enroll in advanced courses selected from disciplines in the Colleges of Sciences or Engineering.	3
D. 3 semester credit hours of Internship and Research Project: *	3
AIM 6943 Internship and Research Project	
E. 6 semester credit hours selected from coursework in communications, leadership skills, and business principles such as:	6
MGT 5003 Conceptual Foundations of Management	
MGT 5043 Management and Behavior in Organizations	
MGT 5093 Leadership	
Total Credit Hours	36

* Internship and Research Project

Upon completion of 18 semester credit hours in mathematics, a student is eligible to enroll in AIM 6943 Internship and Research Project. The student must spend a semester in an industrial setting and must complete an internship-related project. To complete the internship-related project, the student will:

1. Submit either an employment letter from a company or a pre-internship proposal outlining the proposed work for approval by the student's Supervising Professor.
2. Complete the proposed work after the internship has been completed.
3. Defend the project before the deadlines set forth by the University.

Students currently employed in industry may negotiate an alternative internship experience.

Master of Science Degree in Mathematics

Program Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, a Bachelor of Arts or Bachelor of Science in Mathematics is highly recommended as preparation. However, exceptional applicants with a Bachelor's degree in a closely related field may also be considered for admission. Students who do not qualify for unconditional admission should anticipate that additional undergraduate and/or graduate coursework may be required to complete the degree. Applicants should provide scores from the Graduate Record Examination (GRE). It is recommended that the applicant submit two letters of reference, preferably from those who can speak to the applicant's mathematical abilities.

Degree Requirements

Degree candidates are required to successfully complete 36 semester credit hours in one of two concentrations, (1) Mathematics or (2) Applied Mathematics.

A. Students must complete the following 9 hours of required coursework:	9
MAT 5203 Theory of Functions of a Real Variable I	

MAT 5223	Theory of Functions of a Complex Variable I	
MAT 5243	General Topology I	
B. Students must complete 9 hours of required coursework for the selected concentration:		9
Mathematics Concentration		
MAT 5173	Algebra I	
MAT 5283	Linear Algebra	
MAT 5403	Functional Analysis I	
Applied Mathematics Concentration		
MAT 5293	Numerical Linear Algebra	
	or MAT 5603 Numerical Analysis	
MAT 5553	Harmonic Analysis	
	or MAT 5673 Partial Differential Equations I	
MAT 5653	Differential Equations I	
C. Students must normally take an additional 18 semester credit hours of coursework chosen from eligible graduate courses in the Department of Mathematics. Students may apply a maximum of 6 semester credit hours of graduate coursework from other disciplines as approved by the Graduate Advisor of Record. Undergraduate coursework taken for graduate credit must be approved by the Graduate Review Committee and may not exceed 6 hours of credit. If approved to enroll in undergraduate coursework students must complete the Permission for Enrolling in Undergraduate Courses While a Graduate form and receive all approvals. All required courses must be taken in scheduled classes. Approval of Graduate Review Committee is imperative if any required course is to be substituted or taken as an Independent Study.		18
D. Students are required to pass an advanced comprehensive examination or successfully defend their thesis research results.		
Total Credit Hours		36

Master of Science Degree in Mathematics Education

Program Admission Requirements

In addition to satisfying the University-wide graduate admission requirements, a Bachelor of Arts or Bachelor of Science in Mathematics or a closely related field is highly recommended as preparation. Students who do not qualify for unconditional admission should anticipate that additional undergraduate and/or graduate coursework may be required to complete the degree. The applicant must submit two letters of reference, preferably from those who can speak to the applicant's mathematical abilities. Applicants must submit a personal statement describing how an M.S. in Mathematics Education will advance the applicant's personal and professional goals. All required courses must be taken in scheduled classes. Approval of Graduate Review Committee is imperative if any required course is to be substituted or taken as an Independent Study.

Degree Requirements

Degree candidates are required to successfully complete 36 semester credit hours.

A. Students must complete the following courses:		18
MAT 5023	Problem-Solving Seminar	
MAT 5033	Foundations and Fundamental Concepts of Mathematics	
MAT 5043	Euclidean and Non-Euclidean Geometry	
MAT 5103	Introduction to Mathematical Analysis	

MAT 5283	Linear Algebra	
MAT 5963	Introduction to Mathematics Education Research	
B. Students must either write a Master's thesis or complete 6 semester credit hours of advanced courses in the department as approved by the Graduate Advisor of Record.		6
C. Students must normally take an additional 12 semester credit hours of coursework chosen from eligible graduate courses in the Department of Mathematics. Students may apply a maximum of 6 semester credit hours of graduate coursework from other disciplines, MAT 6963 Topics in Mathematics Education, or a combination thereof, as approved by the Graduate Advisor of Record.		12
D. Students are required to pass an advanced comprehensive examination or successfully defend their thesis research results.		
Total Credit Hours		36

Applied-Industrial Mathematics (AIM) Courses

AIM 5113. Introduction to Industrial Mathematics. (3-0) 3 Credit Hours.
Prerequisites: MAT 1214, MAT 1224, and MAT 2233, or consent of instructor. The topics covered include quality control, Monte Carlo methods, linear programming, model fitting, frequency domain methods, difference and differential equations, and report writing. The course is not designed to substitute for any specialized course covering these topics in detail, but rather to survey their real-world applications. Differential Tuition: \$150. Course Fees: GS01 \$90.

AIM 6943. Internship and Research Project. (0-0) 3 Credit Hours.
Prerequisites: Completion of at least 18 semester credit hours of coursework in mathematics and consent of the student's Supervising Professor; confirmation of approved internship. Provides students with hands-on experience in industrial mathematics or a related field in a professional environment. The research work may be either an extended project or a variety of shorter assignments. May be repeated for credit, but no more than 6 credit hours will apply toward the Master's degree. Differential Tuition: \$150. Course Fees: GS01 \$90.

Mathematics (MAT) Courses

MAT 5003. Modern Mathematics for Teachers. (3-0) 3 Credit Hours.
A practical orientation concerned with the classroom uses of mathematics for teachers of K-12. This course may not be applied toward the Master of Science degree in Mathematics. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5013. Computers for Mathematics Teachers. (3-0) 3 Credit Hours.
A course for mathematics teachers on integrating the computer into the mathematics curriculum, with a focus on mathematical problem solving through the use of mathematical software packages. This course may not be applied to the Master of Science degree in Mathematics. (Credit cannot be earned for more than one of the following: MAT 5013, CS 5023 or CS 5063.) Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5023. Problem-Solving Seminar. (3-0) 3 Credit Hours.
Students will have the opportunity to engage in extensive experience and practice in solving mathematical problems. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5033. Foundations and Fundamental Concepts of Mathematics. (3-0) 3 Credit Hours.

Topics include the study of mathematics in antiquity as an empirical science, the shift from inductive reasoning to axiomatic structures, the development of geometry in the plane and 3-space, the discovery of analysis, the emergence of axiomatic systems, and the focus on algebraic structures. This course may not be applied to the Master of Science degree in Mathematics without approval of the Graduate Advisor of Record and the Graduate Review Committee. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5043. Euclidean and Non-Euclidean Geometry. (3-0) 3 Credit Hours.

Topics will be selected from advanced Euclidean and non-Euclidean geometry, solid analytic geometry, and differential geometry. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5103. Introduction to Mathematical Analysis. (3-0) 3 Credit Hours.

Prerequisite: MAT 4213 or consent of instructor. Axiomatic construction of the reals, metric spaces, continuous functions, differentiation and integration, partial derivatives, and multiple integration. This course may not be applied to the Master of Science degree in Mathematics. (Credit cannot be earned for both MAT 5103 and MAT 5203.) Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5123. Introduction to Cryptography. (3-0) 3 Credit Hours.

Prerequisite: MAT 4213. Congruences and residue class rings, Fermat's Little Theorem, the Euler phi-function, the Chinese Remainder Theorem, complexity, symmetric-key cryptosystems, cyclic groups, primitive roots, discrete logarithms, one-way functions, public-key cryptosystems, digital signatures, finite fields, and elliptic curves. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5173. Algebra I. (3-0) 3 Credit Hours.

Prerequisite: MAT 4233 or consent of instructor. The opportunity for development of basic theory of algebraic structures. Areas of study may include monoids, semigroups, groups, isomorphism theorems, free groups, group extensions and group actions, Sylow theorems, group chains and composition series, nilpotent and solvable groups, cohomology of groups. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5183. Algebra II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5173. Areas of study may include: Theory of rings, ideals, chain conditions, Artin and Noether rings, Ore conditions and ring of fractions, Jacobson radicals, group rings, modules, module homomorphisms, free modules, tensor products, modules over principal ideal domains, algebras, Galois theory. Formerly MAT 5313. Credit cannot be earned for both MAT 5313 and MAT 5183. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5203. Theory of Functions of a Real Variable I. (3-0) 3 Credit Hours.

Prerequisite: MAT 4213 or consent of instructor. Measure and integration theory. (Credit cannot be earned for both MAT 5203 and MAT 5103.) Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5213. Theory of Functions of a Real Variable II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5203. Further development of measure and integration theory, metric space topology, and elementary Banach space theory. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5223. Theory of Functions of a Complex Variable I. (3-0) 3 Credit Hours.

Prerequisite: MAT 3213 or MAT 4213. Complex integration, Cauchy's theorem, calculus of residues, and power series. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5233. Theory of Functions of a Complex Variable II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5223. Infinite products, entire functions, Picard's theorem, Riemann mapping theorem, and functions of several complex variables. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5243. General Topology I. (3-0) 3 Credit Hours.

Prerequisite: MAT 4273 or consent of instructor. Topological spaces, metric spaces, continua, and plane topology. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5253. General Topology II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5243. Topics may include: Metrizable topological spaces, function spaces, covering spaces, homotopy theory and fundamental groups, classification of surfaces, and others. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5263. Algebraic Topology. (3-0) 3 Credit Hours.

Prerequisite: MAT 4273 or MAT 5243. Fundamental ideas of algebraic topology, homotopy and simplicial complexes, fundamental group, covering spaces, and duality theorems. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5283. Linear Algebra. (3-0) 3 Credit Hours.

Prerequisite: MAT 2233 or an equivalent. A study of linear algebraic structures that may include linear transformations, inner product spaces, eigenvalues, Cayley-Hamilton theorem, similarity, the Jordan canonical form, spectral theorem for normal transformation and applications. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5293. Numerical Linear Algebra. (3-0) 3 Credit Hours.

Prerequisite: MAT 2233 or an equivalent. Direct and iterative methods for solving general linear systems, the algebraic eigenvalue problem, least squares problems, and solutions of sparse systems arising from partial differential equations. (Same as CS 5293. Credit cannot be earned for both MAT 5293 and CS 5293.) Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5323. Mathematical Modeling. (3-0) 3 Credit Hours.

Prerequisite: MAT 3633 or equivalent. Techniques of mathematical modeling for applications, including ordinary and partial differential equations, stochastic models, discrete models and optimization, modeling error and uncertainty quantification. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5343. Differential Geometry. (3-0) 3 Credit Hours.

Prerequisites: MAT 4223 and MAT 4273, or equivalents. Multilinear algebra, differentiable manifolds, exterior differential forms, affine connections, Riemannian geometry, and curvature equations. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5353. Mathematics of Image Processing. (3-0) 3 Credit Hours.

Prerequisite: MAT 5613 or consent of instructor. Topics include image acquisition, denoising and enhancement, transformations, linear and nonlinear filters, image compression, segmentation and edge detection, morphology, and pattern recognition. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5403. Functional Analysis I. (3-0) 3 Credit Hours.

Prerequisites: MAT 2233, MAT 4273, and MAT 5203, or their equivalents. Topological vector spaces, inner product spaces, normed spaces, Hilbert spaces and Banach spaces, dual spaces, Hahn-Banach theorem, and bounded linear operators. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5413. Functional Analysis II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5403. Riesz representation theorem, spectral theory, Banach algebras, and C*-algebras. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5553. Harmonic Analysis. (3-0) 3 Credit Hours.

Prerequisites: MAT 3223 and MAT 4223, or consent of the instructor. Topics may include properties of Fourier series, convergence and summability, Hardy spaces, boundary behavior and harmonic functions, and other topics at the discretion of the instructor. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5603. Numerical Analysis. (3-0) 3 Credit Hours.

Prerequisite: MAT 3633 or consent of instructor. Emphasis on the mathematical analysis of numerical methods. Areas of study include solution of nonlinear equations and function optimization, approximation theory and numerical quadrature. (Same as CS 5603. Credit cannot be earned for both MAT 5603 and CS 5603.) Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5613. Numerical Solutions of Differential Equations. (3-0) 3 Credit Hours.

Prerequisite: MAT 5603 or an equivalent. Emphasis on the mathematical analysis of numerical methods. Areas of study include the analysis of single and multistep methods of ordinary differential equations. Analysis of finite difference and finite element methods for partial differential equations. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5653. Differential Equations I. (3-0) 3 Credit Hours.

Prerequisites: MAT 3613 and MAT 4213, or consent of instructor. Solution of initial-value problems, linear systems with constant coefficients, exponentials of operators, canonical forms and generic properties of operators, and contractions. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5663. Differential Equations II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5653. Dynamic systems, the fundamental existence and uniqueness theorem, stability, the Poincare-Bendixson theorem, introduction to perturbation, and bifurcation theory. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5673. Partial Differential Equations I. (3-0) 3 Credit Hours.

Prerequisites: MAT 3623 and MAT 5663, or consent of instructor. Classical theory of initial value and boundary value problems for partial differential equations, including the heat equation, wave equation, and Laplace equation, et al., and non-linear first and second order partial differential equations and calculus of variation. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5683. Partial Differential Equations II. (3-0) 3 Credit Hours.

Prerequisite: MAT 5673. Modern topics in partial differential equations. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5963. Introduction to Mathematics Education Research. (3-0) 3 Credit Hours.

Prerequisite: Consent of instructor. An introduction to important research and findings in mathematics education. Students will gain experience with interpreting education research and translating it into practice. Students will work on projects designed to help them investigate their own teaching practice. Topics include: mathematical learning theories, philosophical perspectives of mathematics, explorations of mathematical content, and research on student learning. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5973. Directed Research. (0-0) 3 Credit Hours.

Prerequisites: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 5983. Topics in Applied Mathematics. (3-0) 3 Credit Hours.

Prerequisite: Graduate standing or consent of instructor. In-depth study of current topics in applied mathematics. May be repeated for credit when topics vary. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 6603. Optimization Techniques in Operations Research. (3-0) 3 Credit Hours.

Prerequisite: MAT 2214, MAT 2233, or consent of instructor. Analysis and application of optimization techniques in operations research. Emphasis on linear programming, nonlinear programming, and integer programming. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 6953. Independent Study. (0-0) 3 Credit Hours.

Prerequisites: Graduate standing and permission in writing (form available) from the instructor and the student's Graduate Advisor of Record. Independent reading, research, discussion, and/or writing under the direction of a faculty member. For students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 6961. Comprehensive Examination. (0-0) 1 Credit Hour.

Prerequisite: Approval of the appropriate graduate program committee to take the Comprehensive Examination. Independent study course for the purpose of taking the Comprehensive Examination. May be repeated as many times as approved by the Graduate Program Committee. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). Differential Tuition: \$50. Course Fees: GS01 \$30.

MAT 6963. Topics in Mathematics Education. (3-0) 3 Credit Hours.

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. This course may be repeated for credit when topics vary but not more than 9 hours may be applied toward the Master's degree. This course may not be applied toward the Master of Science degree in Mathematics with a concentration in Mathematics. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 6973. Special Problems. (3-0) 3 Credit Hours.

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Problems courses may be repeated for credit when topics vary, but not more than 6 hours, regardless of discipline, will apply to the Master's degree. Differential Tuition: \$150. Course Fees: GS01 \$90.

MAT 6983. Master's Thesis. (0-0) 3 Credit Hours.

Prerequisites: Permission from the Graduate Advisor of Record and thesis director. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. Enrollment is required each term in which the thesis is in progress. Differential Tuition: \$150. Course Fees: GS01 \$90.