MATHEMATICS

Douglas A. Norris	Chair; Differential Geometry
Patrick B. Chen	Topological Groups; Lie Groups
Barbara K. D'Ambrosia	Ring Theory
Brendan Foreman	Differential Geometry; Math Education
Frederick J. Fuglister	Algebraic Combinatorics
Darrell J. Horwath	Algebra
Marc Kirschenbaum	Topology; Swarm Intelligence
Robert J. Kolesar	Algebraic Topology
Jerry L. Moreno	Probability; Statistics; Operations Research
Dwight M. Olson	Ring Theory
Daniel W. Palmer	Computer Science; Swarm Intelligence
Leo J. Schneider	Differential Equations
Linda M. Seiter	Software Engineering
Paul L. Shick	Algebraic Topology
Carl R. Spitznagel	Algebra
David L. Stenson	Topological Algebra

The Department of Mathematics offers three distinct graduate programs in mathematics. The Master of Science program blends theoretical material necessary for further graduate work in mathematics with basic applications for the student who wishes to enter industry or government work in mathematics. There are two graduate programs in mathematics designed for teachers that lead to a Master of Arts Degree, one for high school teachers and the other for middle school teachers. These programs reflect the standards of the National Council of Teachers of Mathematics (NCTM) and the recommendations of the Mathematical Association of America (MAA). The courses combine mathematical topics related to the curriculum with enrichment material which is directly applicable to the classroom.

Under the department's five-year B.S./M.S. in Mathematics program, students may earn both degrees in five years if they have sufficient AP credit (eight AP Math credits plus six other AP credits) and meet all other requirements of both undergraduate and graduate degrees.

Master of Science

In this program the student acquires the mathematical background for further study toward the doctorate in mathematics or for applying mathematics in business and research.

All Master of Science students must complete ten courses, including at least six of the eight courses numbered 531-579. These courses form the core of the program. None of the graduate courses from the Master of Arts programs is allowed. The material from MT 341, 342, elementary abstract and linear algebra, is presupposed in all Master of Science courses. The material from MT 431 is presupposed in all 500-level Master of Science courses.

The courses required for the degree are offered in a two-year cycle, so that a full-time student may fulfill the requirements for a degree in two years. A part-time student may complete the requirements in three years. Part-time students may take at most two courses a semester. A schedule of applicable courses for this degree is available in the Mathematics Department.

Requirements for the Degree

1. Ten courses (30 semester hours) in mathematics, including at least six courses numbered 531-579
2. A research paper
3. A comprehensive examination

MATHEMATICS

Admission Requirements

Applicants to the Master of Science in Mathematics program should have completed at least seven undergraduate courses in pure or applied mathematics beyond nine hours of calculus. Some courses in applied mathematics may be from physics or engineering.

Applicants to the Master of Arts in Mathematics for High School Teachers or for Middle School Teachers must have fulfilled the requirements of their state for certification to teach mathematics in high school or middle school respectively, with an undergraduate mathematics average of at least 2.5. Other teachers of high school or middle school mathematics may be admitted to the programs on a provisional status until they can demonstrate the ability to succeed in the program.

All prospective students should arrange for a conference with a member of the Mathematics Department before registration.

Master of Arts

This is a terminal degree for high school and middle school teachers of mathematics.

Program for High School Teachers

Students in the Master of Arts Program in Mathematics for High School Teachers must complete ten courses, including at least six courses numbered 500-519. These 500-level courses are specially designed to utilize the background and meet the needs of high school teachers. None of the graduate courses from the program for middle school teachers are allowed. Courses are offered in a three-year summer cycle, and also in evenings during the fall and spring semesters. A student may complete the required courses by taking courses during two consecutive summers and the intervening school year, or in three consecutive summers.

Requirements for the Degree

1. Ten courses (30 semester hours) in mathematics, including at least six courses numbered 500-519
2. An expository essay
3. A comprehensive examination

Program for Middle School Teachers

Students in the Master of Arts Program for Middle School Teachers must complete the eleven courses numbered 520-530. These 500-level courses are specially designed to utilize the background and meet the needs of middle school teachers. Courses are offered in a two-year cycle.

Requirements for the Degree

1. Eleven courses (33 semester hours) in mathematics, numbered 520-530
2. An expository essay
3. A comprehensive examination

COURSE DESCRIPTIONS

420. PROBABILITY AND STATISTICS I 4 cr. Prerequisite: MT 233. Combinatorial probability, discrete and continuous distributions, simulation of sampling distributions and the central limit theorem, introduction to data analysis, estimation and hypothesis testing; use of CAS and statistical software.

421. PROBABILITY AND STATISTICS II 3 cr. Prerequisite: MT 420. Mathematical treatment of estimation and hypothesis testing, including one and two-factor analysis of variance, simple regression and correlation, and nonparametric analyses.

422. APPLIED STATISTICS 3 cr. Prerequisites: MT 342, 420. Categorical data analysis, multiple regression, analysis of variance of various designs, introduction to design of experiments. Use of statistical software.

425. OPERATIONS RESEARCH 3 cr. Prerequisite: MT 342. Linear programming, sensitivity analysis and duality, queuing theory, and topics from networks, decision making, game theory, Markov chains, dynamic programming, and simulation.

431. ADVANCED CALCULUS OF ONE VARIABLE 3 cr. Prerequisites: MT 233, 341. Real-number system, limits, continuity, differentiability, Riemann integral, properties of continuous and differentiable functions, sequences and series of functions.

432. ADVANCED CALCULUS OF SEVERAL VARIABLES 3 cr. Prerequisites: MT 233, 342. Development of and motivation for vector-valued functions, calculus of functions of several variables, implicit functions and Jacobians, multiple integrals, line integrals.

436. INTRODUCTION TO COMPLEX ANALYSIS 3 cr. Prerequisite: MT 341 or 342 or permission of department chair. Complex number plane, analytic functions, integration of complex functions, sequences and series. Residue theorem, evaluation of real integrals.

438. ORDINARY LINEAR DIFFERENTIAL EQUATIONS 3 cr. Prerequisites: MT 233, 342. Linear equations and systems, existence and uniqueness theorems, oscillation theory. Autonomous equations and systems, their solutions and qualitative properties.

441. ABSTRACT ALGEBRA 3 cr. Prerequisite: MT 341. Groups, rings, domains, fields, extension fields, introduction to Galois Theory.

442. LINEAR ALGEBRA 3 cr. Prerequisite: MT 342. Vector spaces, linear transformations, characteristic values and applications.

450. EUCLIDEAN AND NON-EUCLIDEAN GEOMETRY 3 cr. Prerequisite: MT 341 or 342 or permission of department chair. Alternative ways of investigating the Euclidean plane, including transformational geometry; examination of the parallel postulate and how it can be changed to create new geometries; hyperbolic geometry.

452. ELEMENTARY TOPOLOGY 3 cr. Prerequisite: MT 341. Topological spaces, homeomorphisms, connected spaces, compact spaces, regular and normal spaces, metric spaces.

456. FRACTAL GEOMETRY 3 cr. Prerequisites: MT 233, 341. Topics from metric spaces, transformations, iterated function systems, dynamical systems, fractal dimension, Julia sets, and Mandelbrot sets.

468. THEORY OF NUMBERS 3 cr. Prerequisite: MT 341. Divisibility theorems, number-theoretic functions, primitive roots, quadratic congruences and reciprocity, partitions.

469. HISTORY OF MATHEMATICS 3 cr. Prerequisite: MT 341. Study of mathematics from its origins to its present state. Topics include the development and impact of geometry, algebra, number theory, irrational numbers, analytic geometry, calculus, non-Euclidean geometry, and infinite sets.

478. FORMAL LANGUAGES 3 cr. Prerequisites: MT 341 or MT 379 or equivalent. Finite and push-down automata and Turing machines. Regular languages, context-free grammars, recursive and recursively enumerable languages. Other topics chosen from Church's thesis, Gödel numbering, decidability, and recursive functions.

479. COMBINATORICS AND GRAPH THEORY 3 cr. Prerequisite: MT 341 or 342 or 379. Pigeonhole principle, inclusion and exclusion, recurrence relations and generating functions, combinatorial designs, the theory of graphs, graphical optimization problems.

480. SPECIAL TOPICS cr. TBA. Reading, reports on, and investigation of selected material and topics.

501. MATHEMATICAL STRUCTURES 3 cr. Topics selected from set theory, cardinality, axiomatic and constructive approaches to the number systems, algebraic structures.

502. DISCRETE MATHEMATICS 3 cr. Matrices, graph theory, iterative processes, game theory, and applications.

503. MODERN GEOMETRY 3 cr. Euclidean and non-Euclidean geometries. Axiomatic, transformational, and metric approaches to geometry.

504. CURVES, SURFACES AND SPACE 3 cr. Examination of the topology and geometry of two, three, and four-dimensional spaces. Visualization and classification of mathematical spaces. Shape and curvature of the universe.

505. TOPICS IN CALCULUS 3 cr. Alternative approaches to selected topics in the traditional calculus course. Designed for the teacher of calculus who wishes to deepen and broaden his/her understanding of this area.

507. STATISTICAL LITERACY 3 cr. Graphical approach to data analysis, probability, art and techniques of simulation, surveys and information from samples, confidence intervals and tests of hypotheses. Emphasis is on material applicable to the high school curriculum.

509. GREAT MOMENTS IN MATHEMATICS 3 cr. Survey of some of the more important historical developments in the history of mathematics, with emphasis on those with connections to the secondary curriculum.

510. MATHEMATICAL POTPOURRI 3 cr. Topics in and about mathematics, including famous problems, enrichment and appreciation material, and the use of these topics in the high-school curriculum.

512. TECHNOLOGY IN THE TEACHING OF MATHEMATICS 3 cr. Seminar/lab course in the use of graphing calculators and computer software in teaching high school mathematics. Students will collaborate in developing classroom and laboratory activities for use in the secondary curriculum.

513. COMPUTER SCIENCE FOR HIGH-SCHOOL TEACHERS 3 cr. Introduction to programming, algorithms and data structures. Covers material included in the high school Advanced Placement Computer Science course (AB level) and other topics as time permits.

514. PROBLEMS IN MATHEMATICS 3 cr. Old and new problems from various areas of mathematics, chosen to be applicable to co-curricular high school activities such as mathematics clubs and contests.

MATHEMATICS

515. CHAOS AND FRACTALS IN THE CLASSROOM 3 cr. Overview of chaotic dynamical systems and associated fractals; computerized explorations of chaos and fractals, and their use in the high school curriculum.

519. SPECIAL TOPICS IN MATHEMATICS cr. TBA Supervised study of special topics.

520. MATHEMATICS–PROCESS AND CONTENT 3 cr. Introduction to the NCTM content and process standards. The study of middle grades mathematics from an advanced perspective emphasizing the nature of mathematics. Exploration of the connections between middle grades mathematical content and higher-level mathematics. Relationship between content knowledge and best practice teaching.

521. NUMBER ANALYSIS 3 cr. Properties and structure of number systems. Connections between analytical and geometrical understanding of number concepts. Equivalent representations of numbers and an examination of the difficulties students experience in the recognition of those equivalences. Estimation and mental calculation and their relation to understanding properties of numbers. Number theory. Limit and completeness of the real numbers.

522. CONCEPTS IN ALGEBRA 3 cr. Examination of algebraic structures and how they are related to middle school mathematics. Patterns, relations, functions. Linear approximation and rates of change. Interconnectedness of algebra to other mathematical concepts in the middle school curriculum. Algebra used to describe symmetry.

523. DISCRETE MATHEMATICS AND LINEAR ALGEBRA 3 cr. Combinatorics as systematic counting. Iteration and recursion. Vertex-edge graphs. Pattern and symmetry. Matrix representation of data. Linear algebra in transformational geometry.

524. GEOMETRY AND SPATIAL SENSE 3 cr. Constructivist approach to geometry using exploratory, discovery and hands-on methods for generating conjectures and verifying results. Axiomatic deductive reasoning. Euclidean, transformational, and non-Euclidean geometry. Constructions used as a way to promote logical reasoning.

525. MATHEMATICS TEACHING TECHNOLOGY 3 cr. Examination of how mathematics teaching technology is used to promote the discovery and understanding of various mathematical concepts. Graphing calculators, spreadsheets, dynamic geometry software, computer algebra systems, mathematics on the web.

526. RESPONSIVE MATHEMATICS INSTRUCTION 3 cr. Developmental psychology of middle grades students and the related impact on the teaching of mathematics. Examination of mathematics education research related to the middle grades. Methodology of teacher action research. Appropriate mathematics instruction for diverse groups of students.

527. PROBABILITY AND STATISTICS 3 cr. Study design and data collection. Analysis and representation, notion of distributions, variation and center. Probability and proportional reasoning. Development of hypotheses and statistical methods for comparing and interpreting data. Modeling linear relationships through simulation.

528. TOPICS IN MEASUREMENT 3 cr. The teaching of measurement as recommended by NCTM. Measurement used in mathematical modeling and real world applications. Measurement as an aid to decision making.

529. REASONING AND COMMUNICATION IN MATHEMATICS 3 cr. Distinguishing characteristics of mathematical reasoning. Inductive and deductive mathematical reasoning. Logic and truth.

530. CAPSTONE COURSE 3 cr. Analysis and completion of essay projects. Discussion of comprehensive examination topics as an overview of program concepts.

531. REAL ANALYSIS I 3 cr. Topics on Lebesgue integration theory, including measure, integration, integrable functions. Relation between Lebesgue integral and Riemann integral. Functions of bounded variation, absolute continuity, generalized Fundamental Theorem of Calculus.

532. REAL ANALYSIS II 3 cr. Prerequisite: MT 531. Topics to be selected from: Borel sets, Baire functions, ordinal numbers, Lebesgue measure, absolute continuity, Lebesgue-Stieljes integral, signed measures, Radon-Nikodym theorem, product measures and Fubini's theorem.

536. COMPLEX ANALYSIS 3 cr. Prerequisite: MT 431. Topology of the complex plane, analytic functions, integration theory, Riemann Mapping Theorem, analytic continuation, Riemann surfaces, harmonic functions.

538. FUNCTIONAL ANALYSIS 3 cr. Prerequisite: MT 452. Topics to be selected from: normed spaces, linear functionals, Hahn-Banach theorem, dual space, inner-product space, Riesz-Fischer theorem, linear operators.

541. ALGEBRA I 3 cr. Groups, homomorphism, group actions, Sylow theorems, rings and ideals, polynomials, and p.i.d.s.

542. ALGEBRA II 3 cr. Prerequisite: MT 541. Topics to be selected from: projective and injective modules, structure of semigroups, rings, radicals and Galois Theory.

552. GENERAL TOPOLOGY 3 cr. Prerequisite: MT 452. Topics to be selected from: topological spaces and mappings, topological and homotopic invariants, product and quotient spaces, topological constructions, separation axioms, metrization, generalized convergence, fundamental group.

557. DIFFERENTIAL GEOMETRY 3 cr. Prerequisite: MT 431. Local and global properties of curves and surfaces; Gauss map, curvature, Theorema Egregium, covariant derivative, geodesics, Gauss-Bonnet Theorem, generalizations to manifolds.

580. SPECIAL TOPICS cr. TBA. Readings, reports on, and investigations of selected material and topics.