Mathematics (MT)

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Major Programs

The Department of Mathematics and Computer Science offers two major programs in mathematics. The department also offers computer science programs described in the separate section on Computer Science (CS).

The major in Mathematics leading to the Bachelor of Science prepares students for immediate employment after completion of the degree or for graduate study. It is designed to give students a broad background in all the major areas of mathematics, while remaining flexible enough to allow students to tailor the program to meet their career objectives. Graduates have entered graduate programs in mathematics, statistics, and operations research/supply chain management at many leading universities, while others have entered into a variety of employment situations— as actuaries, statisticians, analysts, computer programmers, systems analysts and teachers. Other graduates have entered professional schools in law, medicine, and business.

The major in Teaching Mathematics leading to the Bachelor of Arts combines mathematics and education courses for licensure to teach Adolescent to Young Adult (AYA) mathematics.

Teaching Licensure

The mathematics courses necessary for licensure to teach Adolescent to Young Adult (AYA) mathematics are the same as those required for the Bachelor of Arts major in teaching mathematics.

For Middle Childhood (MC) licensure, the mathematics curriculum content courses are MT 135, 162, 175, 221, 241, and 251, plus three additional credits of MT or CS courses.

For Early Childhood (EC) licensure, the mathematics curriculum content courses are MT 175 and 176.

In all cases, the content-area courses for licensure (mathematics and/or computer science) must be completed with a minimum average of 2.7 and a minimum grade of C in each course.

Program Learning Goals in Mathematics: Students will

1. Develop an in-depth integrated knowledge in algebra, geometry, and analysis.
2. Be able to communicate mathematical ideas and present mathematical arguments both in writing and orally using proper use of mathematical notation and terminology.
3. Be able to distinguish coherent mathematical arguments from fallacious ones, and to construct complete formal arguments of previously seen or closely-related results.
4. Be able to give complete solutions to previously seen or closely-related problems.
5. Be able to use definitions, theorems, and techniques learned to solve problems they have not seen before.
6. Be able to synthesize material from multiple perspectives and make connections with other areas.
7. Be able to use technology appropriate to each topic.

Major and Minor Requirements

Major in Mathematics: 45-46 SEMESTER HOURS.
1. **Calculus stream** (12 cr.): MT 135 (or MT 133-134), MT 136, MT 233;

2. **Foundations for Applied Mathematics** 12-13 cr.): Probability and Statistics (MT 229) (3 cr.), Elementary Differential Equations (MT 234) (3 cr.), Elementary Linear Algebra (MT 242) (3 cr.), CS 128-128 L or CS 150 (3-4 cr.);

3. **Fundamentals of Pure Mathematics** (9 cr.): Methods in Pure Mathematics (MT 301), Introduction to Real Analysis (MT 431), Introduction to Abstract Algebra (MT 441);

4. **Mathematics Capstone** (3 cr.): History of Mathematics (MT 469) or Senior Seminar in Mathematics (MT 491);

5. **Electives** (9 cr.): 9 additional credit hours from the elective category of courses.

A comprehensive examination is required.

**Major in Teaching Mathematics**: 36-37 SEMESTER HOURS (PLUS EDUCATION COURSES).

1. **Calculus stream** (12 cr.): MT 135 (or MT 133-134), MT 136, MT 233;

2. **Foundations for Applied Mathematics** (9-10 cr.): Probability and Statistics (MT 229) (3 cr.), Elementary Linear Algebra (MT 242) (3 cr.), CS 128-128 L or CS 150 (3-4 cr.)

3. **Fundamentals of Pure Mathematics** (9 cr.): Methods in Pure Mathematics (MT 301), Introduction to Real Analysis (MT 431), Introduction to Abstract Algebra (MT 441);

4. **Euclidean & Non-Euclidean Geometry** (MT 450) (3 cr.)

5. **Mathematics Capstone**: History of Mathematics (MT469) (3 cr.)

*Required Support Sequence*: 34 semester hours. ED 100, 201, 253, 255, 337, 350, 386, 405C, 427, 444C; PS/ED 262.

A comprehensive examination is required.

**Minor in Mathematics**: 23-24 SEMESTER HOURS.

1. Calculus courses: MT 135 (or MT 133-134), MT 136, MT 233 or MT 234;

2. Elementary Linear Algebra (MT 242) (3 cr.);

3. Methods in Pure Mathematics (MT 301) (3 cr.);

Electives (6 cr.): (See current list below)

**Minor in Statistics & Analytics**: 18-20 semester hours. DATA 100; DATA 260/MT 223; DATA/MT 422 or an approved internship; DATA/MT 424; two of the following application area elective courses: BI 371, BL 224, BL 240, BL 444, CH 261/263, CH 441/443, CS 307, CS 322, CS 350, DATA/MT 421, EC 409, EC 410, ED 201, EPA 230, EPA 407, EPA 340, EPA 430, MK 402, MT 242, PO 300, PS301/301L, PS 401, PS 435, SOC 350, SOC 351.

**Minor in Actuarial Science**: 30 semester hours. MT 135, 136, 233, 229 (or other statistics course), 421, 424, 225 and EC 201-202. These courses prepare the students for Exams P and FM of the Society of Actuaries, cover the required Foundational Quantitative content areas and provide the Validation by Educational Experience (VEE) for Applied Stats and Economics.
LIST OF ELECTIVES FOR BS IN MATHEMATICS AND MINOR IN MATHEMATICS:
425. Operations Research 3 cr. Prerequisite: MT 301.
432. Advanced Calculus of Several Variables 3 cr. Prerequisites: MT 233, 301.
436. Introduction to Complex Analysis 3 cr. Prerequisite: MT 301 or permission.
442. Linear Algebra and Vector Spaces 3 cr. Prerequisite: MT 242, 301.
450. Euclidean and Non-Euclidean Geometry 3 cr. Prerequisite: MT 301 or permission
452. Elementary Topology 3 cr. Prerequisite: MT 301.
453. Differential Equations and Dynamical Systems 3 cr. Prerequisites: MT 233, 234.
468. Theory of Numbers 3 cr. Prerequisite: MT 301.
469. History of Mathematics* 3 cr. Prerequisite: MT 301.
479. Combinatorics and Graph Theory 3 cr. Prerequisite: MT 301.
480. Special Topics cr. TBA.
499. Independent Study in Mathematics 1-4 cr. Prerequisite: consent of chair and instructor.

*Note: B.S. Majors in Mathematics may take MT 469 either as an elective or as their capstone, but not both.

118. APPLIED MATHEMATICS 3 cr. Introduction to the use of mathematics to model various aspects of everyday life. Topics include application of graphs and networks to urban services and business efficiency, planning and job scheduling, interpreting data for decision making, digital information representation, growth, voting systems, and fair division.

119. QUANTITATIVE ANALYSIS 3 cr. Introduction to the study of numbers and subsequent analysis of quantified data using mathematical techniques in studying problems in the context of various disciplines. Mathematical techniques include displaying and describing data, making statistical inferences from data, and building models by fitting functions to data.

122. ELEMENTARY STATISTICS (DATA 122) 3 cr. Describing data by graphs and measures, sampling distributions, confidence intervals and tests of hypotheses for one and two means and proportions, Chi-square tests, correlation and regression. Methods are illustrated in the context of quantitative research, with applications in disciplines such as sports, psychology, and social and natural sciences. Use of appropriate statistical software.

130. APPLIED CALCULUS 3 cr. Prerequisite: placement by the Math Department. Limits, derivatives, definite and indefinite integrals of polynomial, exponential, and logarithmic functions. Focus on concepts and applications, particularly those pertaining to business fields. Use of a computer algebra system to facilitate computation.

133-134. CALCULUS AND ANALYTIC GEOMETRY IA-IB 3 cr. each. Prerequisite: placement by the Math Department. Sequence covers the same calculus topics as MT 135 with algebra review integrated into the course as needed. The MT 133-134 sequence will count as one course in Division IV of the Core, but neither MT 133 nor MT 134 will count as a Core course individually. Note: MT 133-134 will satisfy the MT 135 or equivalent prerequisites and requirements listed throughout the Bulletin. Academic credit will not be given for both MT 134 and MT 135.

135. CALCULUS AND ANALYTIC GEOMETRY I 4 cr. Prerequisite: placement by the Math Department. Functions, limits, continuity, differentiation, differentiation rules, optimization, antiderivatives, definite integrals. Fundamental Theorem of Calculus, improper integrals, applications of integrals, including probability. (See “Note” in MT 133-134.)

136. CALCULUS AND ANALYTIC GEOMETRY II 4 cr. Prerequisite: MT 135 or equivalent. Second course in a three-semester calculus sequence. Parametric curves, differentials, related rates, techniques of integration, additional applications of integrals, introduction to differential equations, polar coordinates, sequences, and series.

142. INTRODUCTION TO DISCRETE MATHEMATICS 3 cr. Mathematical foundations for computer science. Possible topics include: number representation and computation; deductive inference such as proof by induction; data representation as graphs and trees; analysis of time and space complexity of algorithms; Boolean algebra and computer logic; and encryption.

162. MATHEMATICS FROM NON-WESTERN CULTURES 3 cr. Introduction to mathematics developed in non-Western and Native American societies, and illustrations of modern mathematical ideas within non-Western cultures. Topics include arithmetic in positional number systems, arithmetic and geometric sequences, methods of solving linear equations, geometry and symmetry, and games.

171. FOUNDATIONS OF EARLY CHILDHOOD MATHEMATICS 4 cr. Prerequisite: MT 160 or MT 200. Focus on understanding, from an advanced standpoint, the mathematics taught in elementary school. Curriculum issues, methods, instructional resources, and assessment strategies for grades pre-K through 3 will be addressed.

175. FOUNDATIONS OF ELEMENTARY MATHEMATICS 3 cr. For students seeking licensure in Early childhood Education or Middle Childhood Education with Mathematics Concentration. Explorations of the elements of mathematical thinking—reasoning and proof, problem-solving, pattern-finding—and their impact on elementary quantitative concepts and structure. Focus on the development of the real number system and its structure as utilized in Elementary Mathematics: counting numbers, fractions, integers, operations, algebraic properties and some of their applications in measurement, geometry and statistics.

176. TOPICS IN EARLY CHILDHOOD MATH 4 cr. Prerequisite: MT 175 or chair permission. For students seeking licensure in Early Childhood Education. Continued exploration of mathematics taught in elementary school from an advanced standpoint. Topics include number theory, measurement, geometry, symmetry, statistics. Demonstrations of how various models—visual, verbal, physical, writing—are used to convey mathematical instruction in and Elementary School setting.

199. SPECIAL TOPICS IN MATH 1-3 cr. Subject announced in schedule of classes.

200. EXPLORATIONS IN MATHEMATICS 3 cr. Introduction to the nature of mathematics emphasizing the exploration that leads to deep ideas as well as connections between different areas. Models and development of deeper mathematical thinking using concepts that have advanced the discipline.

221. COMBINATORICS, PROBABILITY, AND STATISTICS IN MIDDLE SCHOOL MATH 3 cr. Recursive relationships, counting techniques with applications to theoretical probability, principles of data collection and analysis, graphical and numerical representations of data, principles of statistical inference via resampling, and other techniques.

223. INTERMEDIATE STATISTICS (DATA 260) 3 cr. Prerequisite: DATA/MT 122 or DATA/MT228 or DATA/MT229 or EC208. Power analysis, factorial and repeated measures, analysis of variance, nonparametric procedures, contingency tables, introduction to multiple regression. Use of appropriate statistical software.

225. ACTUARIAL MATHEMATICS 3 cr. Prerequisite: MT 135 or 130. Theory of interest: time value of money, annuities, and cash flow. Mathematical models of loans, bonds, general cash flows, and portfolios. Quantitative analysis of financial economics: derivatives, options, forwards, futures, swaps. MT 225 will prepare students to take Society of Actuaries exam 2/FM.

228. STATISTICS FOR THE BIOLOGICAL SCIENCES (DATA 228) 3 cr. Exploratory data analysis, probability fundamentals, sampling distributions and the Central Limit Theorem, estimation and tests of hypotheses through one-factor analysis of variance, simple linear regression, and contingency tables using appropriate statistical software. Course content in biology context.

229. PROBABILITY AND STATISTICS (DATA 229) 3 cr. Prerequisite: MT 135. Probability, discrete and continuous distributions, sampling distributions and the Central Limit Theorem, introduction to data analysis, estimation and hypothesis testing, simple linear regression and correlation: exact, normal-theory, and simulation-based inference; use of appropriate statistical software. Methods are illustrated in the context of quantitative research, with applications in disciplines such as sports, psychology, and social and natural sciences.

232. CALCULUS AND ANALYTIC GEOMETRY III 4 cr. Prerequisite: MT 136. Calculus of vector-valued functions; partial differentiation; multiple, line, and surface integrals.


241. NUMERICAL AND ALGEBRAIC CONCEPTS FOR MIDDLE SCHOOL MATHEMATICS TEACHERS 3 cr. Prerequisite: MT 135 or MT 160 or MT 200. For students seeking licensure to teach mathematics in grades 4-9. Topics include properties of the integers, rational and irrational numbers, algebra and algebraic thinking, sequences, functions, and sets. Students will learn to communicate in the precise language of mathematics, to make connections among mathematical systems, and to construct valid mathematical arguments and proofs.

242. INTRODUCTION TO LINEAR ALGEBRA 3 cr. Prerequisite: MT 130 or MT 135 Matrix operations, systems of linear equations, vector spaces, subspaces, bases and linear independence, eigenvalues and eigenvectors, diagonalization of matrices, linear transformations, determinants and applications.

251. GEOMETRY FOR MIDDLE SCHOOL MATHEMATICS TEACHERS 3 cr. Prerequisites: MT 135 For students seeking licensure to teach mathematics in grades 4-9. Examination of geometric concepts related to the middle-school
curriculum. Axiomatic foundations and transformational geometry. The use of teaching manipulatives and dynamic geometry software to promote understanding. Emphasis on various types of mathematical reasoning needed to establish geometric credibility.


299. SPECIAL TOPICS IN MATH 1-3 cr. Subject announced in schedule of classes.

301. METHODS IN PURE MATHEMATICS 3 cr. Prerequisite/corequisite: Prerequisite/corequisite MT 136. An introduction to basic mathematical terminology and the techniques of abstract mathematics in the context of discrete mathematics. Topics covered include proof and logic, inductive and deductive reasoning, mathematical induction, sets, functions and relations, and counting principles.

399. INDEPENDENT STUDY IN MATHEMATICS 1-4 cr. Prerequisites: permission of chair and instructor. For the student seeking a research project under faculty supervision.

421. MATHEMATICAL STATISTICS (DATA 421) 3 cr. Prerequisites: DATA/MT 229, MT 233. Moment generating functions, transformations, properties of estimators, foundations of hypothesis tests, one- and two-factor analysis of variance, and nonparametric analyses.

422. APPLIED STATISTICS (DATA 422) 3 cr. Prerequisites: DATA 260/MT 223 or chair permission. Multi-factor analysis of variance, interaction, serial correlation, time series, forecasting, multivariate data, categorical data; data reduction; simulation; analysis of large datasets; use of appropriate statistical software.

424. APPLIED REGRESSION ANALYSIS (DATA 424) 3 cr. Prerequisite: DATA 260/MT 223 or chair permission. Multiple linear regression, collinearity, model diagnostics, variable selection, nonlinear models, logistic regression; use of appropriate statistical software.

425. OPERATIONS RESEARCH 3 cr. Prerequisite: MT 271 or 301. Linear programming, sensitivity analysis and duality, queuing theory, topics from networks, decision making, game theory, Markov chains, dynamic programming, and simulation.

431. INTRODUCTION TO REAL ANALYSIS 3 cr. Prerequisites: MT 233, 271 or 301. Rigorous mathematical treatment of the fundamental ideas of calculus: sequences, limits, continuity, differentiation, and integration.

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

436. INTRODUCTION TO COMPLEX ANALYSIS 3 cr. Prerequisite: MT 271 or 301 or permission of department chair. Complex number plane, analytic functions, integration of complex functions, sequences and series, residue theorem, and evaluation of real integrals.

441. INTRODUCTION TO ABSTRACT ALGEBRA 3 cr. Prerequisite: MT 271 or 301. Groups, homomorphisms, permutations, quotient groups, rings, ideals, integral domains, fields, polynomial rings, and factorization.

442. LINEAR ALGEBRA AND VECTOR SPACES 3 cr. Prerequisite: MT 271 or 301. Proof-based introduction to algebra of matrices, linear systems, abstract vector spaces, linear transformations, eigenvectors, and applications.

450. EUCLIDEAN AND NON-EUCLIDEAN GEOMETRY 3 cr. Prerequisite: MT 271 or 301 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 271 or 301. Topological spaces, homeomorphisms, connected spaces, compact spaces, regular and normal spaces, metric spaces, and topology of surfaces.

453. DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS 3 cr. Prerequisite: MT 233. Introduction to the qualitative study of differential equations and related dynamical systems. Topics include first-order differential equations, planar systems and their dynamical classification, general nonlinear systems and their equilibria, closed orbits, limit sets, discrete systems, and applications to mechanics.

468. THEORY OF NUMBERS 3 cr. Prerequisite: MT 271 or 301. Divisibility theorems, number-theoretic functions, primitive roots, quadratic congruences and reciprocity, partitions.

469. HISTORY OF MATHEMATICS 3 cr. Prerequisite: MT 271 or 301. 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.
479. COMBINATORICS AND GRAPH THEORY 3 cr. Prerequisite: MT 271 or 301. Pigeonhole principle, inclusion and exclusion, recurrence relations and generating functions, combinatorial designs, the theory of graphs, graphical optimization problems.

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

491. SENIOR SEMINAR IN MATHEMATICS 3 cr. Prerequisites: MT 271 or 301 and senior standing. The culminating experience of the mathematics major, requiring students to demonstrate mathematical skills through common readings, class discussions, presentations, and written assignments.

499. INDEPENDENT STUDY IN MATHEMATICS 1-4 cr. Prerequisites: permission of chair and instructor. For the student seeking a research project under faculty supervision.