

MATHEMATICS BA, BS AND MINORS

Mathematics

College of Science, Engineering & Technology
Department of Mathematics and Statistics
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Website: www.cset.mnsu.edu/dept/mathstat/

Chair: Ruijun Zhao, PhD

Faculty: Jonathan Harper, PhD; In-Jae Kim, PhD; Namyong Lee, PhD; Hyekyung Min, PhD; Galkande Premaratna, PhD; Mezbahur Rahman, PhD; Brandon Rowekamp, PhD; Deepak Sanjel, PhD; Soo Yeon Shin, PhD; Dan Singer, PhD; Yea-Ling Tsao, PhD; Han Wu, PhD; Hongxia Yin, PhD; Ke Zhu, PhD; Mark Zuiker, PhD

Mathematics in its purest form is an art concerned with ideas. The Department of Mathematics believes that an undergraduate major should be both an introduction to more advanced study and a survey of the many facets of mathematics. From the profound insights of Thales to the undecidability of Godel, from the intuitive to the rigorous, from the abstract to the applied, with a solid emphasis on both the discrete and the continuous cases, the department expects all majors to be engaged in a wide range of mathematical ideas.

Unlike many other disciplines, mathematics is a very structured subject. Consequently, the curriculum consists of sequences of interrelated courses which must be taken in the appropriate order. The department expects that the well prepared student will complete the mathematics major in four years.

The Department offers three mathematics majors and two minors. The primary focus of the B.S. Mathematics Teaching program is to prepare students to teach mathematics at the middle and secondary levels. The B.A. Mathematics and B.S. Mathematics programs are intended to prepare students for advanced study in mathematics or to work in business, industry, or government. The mathematics minor is intended for non-mathematics majors who desire a stronger background in mathematics. The Actuarial Science Minor combines finance, statistics, and mathematics to analyze risk and ensure financial security for individuals, corporations and society at large.

Academic Map/Degree Plan at www.mnsu.edu/programs/#All

POLICIES/INFORMATION

Admission to Major is required to enroll in 300 and 400 level courses. Admission is granted by the Department. Admission requirements are:

- A minimum of 32 earned semester credit hours and a 2.0 minimum cumulative GPA
- Completion of 8 credits of mathematics in courses numbered MATH 121 or higher
- A minimum 2.5 cumulative GPA in mathematics courses.

Contact the College of Science, Engineering and Technology Student Relations Office for application procedures.

Accelerated Combined Degree (BS and MA/MS) Program. Students intending to complete their Bachelor's and Master's degree at Minnesota State Mankato may be granted permission to take classes that count toward their graduate program during their undergraduate studies. Admission to the program is conducted through the department. Upon being accepted, students will be assigned an advisor to aid in the design of an accelerated program of study (generally 5 years). Students must maintain a minimum 3.0 GPA overall and a 3.6 in major (as an undergraduate) to continue in the program. Please contact the Department Graduate Coordinator for detailed information

Course Application Policy. Within each major or minor, no course may be applied to more than one requirement.

Residency Policy. At least 3 credits applied to the mathematics minor must be earned at Minnesota State Mankato.

GPA Policy. Mathematics majors or minors must earn a grade of "C" (2.0) or better in all courses taken for grade that are applied to the major or minor, respectively.

P/N Grading Policy. Not more than one-fourth of the credits in mathematics courses numbered MATH 121 or above can be taken under P/N and applied to a major or minor. All 300 and 400 level courses are offered for grade only with the exception of MATH 487, MATH 498, and MATH 499, which are available for both P/N and letter grade.

Credit by Examination. Credit by examination will not be approved for courses in which a student has already received a grade.

Credit Limitations. A student may accumulate a maximum of six credits from MATH 110 and the College Level Examination Program (CLEP). After completing MATH 122 with a grade of "C" or better, a student may not receive credit for MATH 110, MATH 112, MATH 113, MATH 115, or MATH 180 without the consent of the department. Since the following courses have some common content, credit is not allowed for both MATH 115 and either MATH 112 or MATH 113. A student may not receive credit for MATH 354 or STAT 354 after completing MATH 455 or STAT 455.

Students seeking enrollment in MATH 112 College Algebra, MATH 113 Trigonometry, MATH 115 Precalculus, MATH 121 Calculus I, MATH 130 Finite Mathematics and Introductory Calculus, MATH 201 Elements of Mathematics I, or STAT 154 Elementary Statistics must demonstrate readiness to succeed by satisfying the placement table below.

Course	Minimum ACT/SAT Math Subscore	Minimum Accuplacer Intermediate Algebra Score	Minimum Accuplacer College Level Math Score	Minimum Accuplacer Calculus Readiness Score	Course Prerequisites
Math 112	ACT 22, Old SAT 520, New SAT* 550, 2-digit SAT 27.5** MCA 1158	OR 60	N/A	N/A	OR Grade of P in MATH 098
Math 113	ACT 22, Old SAT 520, New SAT* 550, 2-digit SAT 27.5**	OR 60	AND 84	N/A	OR Math 112 with "C" or better
Math 115	ACT 23, Old SAT 530, New SAT* 560, 2-digit SAT 28**	OR 60	AND 96	N/A	OR Grade of P in MATH 098
Math 121	ACT 24, Old SAT 560, New SAT* 580, 2-digit SAT 29**	OR 60	AND 84	AND 21	OR MATH 115, or both MATH 112 and MATH 113 with a "C" (2.0) or better
Math 130	ACT 23, Old SAT 530, New SAT* 560, 2-digit SAT 28**	OR 60	AND 84	N/A	OR MATH 112 or MATH 115 with a "C" (2.0) or better
Math 181	ACT 23, Old SAT 530, New SAT* 560, 2-digit SAT 28**	OR 60	AND 84	N/A	OR MATH 112 or MATH 115 with a "C" (2.0) or better
Math 201	ACT 22, Old SAT 520, New SAT* 550, 2-digit SAT 27.5** MCA 1148	OR 60	N/A	N/A	OR Grade of P in Math 098 or "C" (2.0) or better in MATH 112, MATH 115, or MATH 12
Stat 154	ACT 19, Old SAT 460, New SAT* 500, 2-digit SAT 25** MCA 1148	OR 60	N/A	N/A	OR Grade of P in Math 098, or "C" (2.0) or better in Math 112, Math 115, or Math 121

*New SAT is June 2016 or later

**Two digit SAT score is also called the SAT Math Composite Score
ACT, SAT, and MCA scores are valid for 5 years

Procedures: Students may substitute for the above requirements based on documentation of:

1. equivalent or higher scores on standardized college admissions tests that report a separate mathematics sub-score within two calendar years;
2. successful completion of equivalent prior post-secondary education, such as course transfer evaluations or Cambridge International Examinations; or
3. enrollment exclusively in non-credit courses or programs.

Substitutions. Students requesting such substitutions should submit the documentation to the Chair of the Department of Mathematics and Statistics for evaluation. The evaluation will be based on nationally accepted concordances between the testing instruments and/or courses. The Chair of the Department of Mathematics and Statistics or designee should respond in writing to student requests within three weeks of receiving them.

Procedure for Waiver

1. Students not meeting the requirements for enrollment in Math 112, Math 201 or Stat 154 may request a waiver to this policy.
2. Written requests for waivers to the policy must be submitted to the Chair of the Department of Mathematics and Statistics, and should include evidence of alternate means of demonstrating readiness for college algebra including but not limited to:
 - a. High school or recent post-secondary coursework which would indicate adequate preparation (transcripts or other records which include course titles, levels and grades are acceptable), or
 - b. Verification of extenuating circumstances which may have affected performance on previous exams.
3. Requests for waivers should be submitted by the following deadlines:
 - a. August 5th for fall semester enrollment,
 - b. December 1st for spring semester enrollment, and
 - c. May 1st for summer session enrollment.
4. The Chair of the Department of Mathematics and Statistics or designee should respond in writing to student requests within three weeks of receiving them.
5. Students whose initial requests are denied may submit a written appeal to the Dean of the College of Science, Engineering and Technology. The Dean should respond in writing, with a copy to the Chair of the Department of Mathematics and Statistics.
6. The Dean's decision is the final step in this appeal process

Policy Rationale: The purpose of the policy is to place students in a course that is developmentally appropriate to help ensure their long term success. Data suggests students not meeting these guidelines have a higher likelihood of having to repeat a course.

MATH BA

Degree completion = 120 credits

Required General Education

MATH 121 Calculus I (4)
MATH 290 Foundations of Mathematics (4)

Major Common Core

MATH 122 Calculus II (4)
MATH 170 Introduction to Mathematical Software Programming (3)
MATH 223 Calculus III (4)
MATH 247 Linear Algebra I (4)
MATH 316 Intermediate Analysis (3)
MATH 345 Abstract Algebra I (4)
MATH 375 Introduction to Discrete Mathematics (4)
MATH 492W Mathematics Capstone Experience (3)

Note: MATH 492 can substitute for MATH 492W

Major Restricted Electives

(Choose a minimum of 12 credits from the following; at least seven (7) credits must be at the 400 level)

MATH 321 Ordinary Differential Equations (4)
MATH 332 College Geometry (4)
MATH 354 Concepts of Probability & Statistics (4)
MATH 402 Introduction to Topology (4)
MATH 411 Introduction to Complex Variables (4)
MATH 417 Real Analysis I (4)
MATH 418 Real Analysis II (3)
MATH 422 Partial Differential Equations (4)
MATH 425 Mathematical Modeling (4)
MATH 428 Linear Optimization Methods (4)
MATH 435 Modern Geometry (4)
MATH 442 Theory of Numbers (4)
MATH 446 Abstract Algebra II (4)
MATH 447 Linear Algebra II (3)
MATH 455 Theory of Statistics I (4)
MATH 456 Theory of Statistics II (4)
MATH 460 Actuarial Applications in Probability (3)
MATH 461 Mathematical Theory of Interest (4)
MATH 470 Numerical Analysis I (4)
MATH 471 Numerical Analysis II (4)
MATH 475 Advanced Mathematical Software Programming (4)
MATH 480 History of Mathematics (3)

STAT 354, STAT 455 and STAT 456 can substitute for MATH 354, MATH 455 and MATH 456, respectively.

Other Graduation Requirements

Language (8 credits)

Required Minor. Yes. Any.

MATH BS

Degree completion = 120 credits

Required General Education

MATH 121 Calculus I (4)
MATH 290 Foundations of Mathematics (4)

Major Common Core

MATH 122 Calculus II (4)
MATH 170 Introduction to Mathematical Software Programming (3)
MATH 223 Calculus III (4)
MATH 247 Linear Algebra I (4)
MATH 316 Intermediate Analysis (3)
MATH 321 Ordinary Differential Equations (4)
MATH 345 Abstract Algebra I (4)
MATH 375 Introduction to Discrete Mathematics (4)
MATH 492W Mathematics Capstone Experience (3)
MATH 492 may substitute for MATH 492W

Major Restricted Electives

Choose a minimum of eleven (11) credits. At least seven (7) credits must be at the 400-level. Credits must be chosen from at least two categories.

Applied Mathematics (choose 0 - 12 credits)

MATH 422 Partial Differential Equations (4)
MATH 425 Mathematical Modeling (4)
MATH 428 Linear Optimization Methods (4)
MATH 470 Numerical Analysis I (4)
MATH 471 Numerical Analysis II (4)
MATH 475 Advanced Mathematical Software Programming (4)

Algebra (choose 0 - 12 credits)

MATH 442 Theory of Numbers (4)
MATH 446 Abstract Algebra II (4)
MATH 447 Linear Algebra II (3)
MATH 475 Advanced Mathematical Software Programming (4)

Analysis, Geometry and Topology (choose 0 - 12 credits)

MATH 332 College Geometry (4)
MATH 402 Introduction to Topology (4)
MATH 411 Introduction to Complex Variables (4)
MATH 417 Real Analysis I (4)
MATH 418 Real Analysis II (3)
MATH 435 Modern Geometry (4)

Statistics and Finance (choose 0 - 12 credits)

STAT 354, STAT 455 and STAT 456 may substitute for MATH 354, MATH 455 and MATH 456, respectively.

MATH	354	Concepts of Probability & Statistics (4)
MATH	455	Theory of Statistics I (4)
MATH	456	Theory of Statistics II (4)
MATH	460	Actuarial Applications in Probability (3)
MATH	461	Mathematical Theory of Interest (4)

Major Unrestricted Electives

Choose 0-10 Credits

MATH	332	College Geometry (4)
MATH	354	Concepts of Probability & Statistics (4)
MATH	402	Introduction to Topology (4)
MATH	411	Introduction to Complex Variables (4)
MATH	417	Real Analysis I (4)
MATH	418	Real Analysis II (3)
MATH	422	Partial Differential Equations (4)
MATH	425	Mathematical Modeling (4)
MATH	428	Linear Optimization Methods (4)
MATH	435	Modern Geometry (4)
MATH	442	Theory of Numbers (4)
MATH	446	Abstract Algebra II (4)
MATH	447	Linear Algebra II (3)
MATH	455	Theory of Statistics I (4)
MATH	456	Theory of Statistics II (4)
MATH	460	Actuarial Applications in Probability (3)
MATH	461	Mathematical Theory of Interest (4)
MATH	470	Numerical Analysis I (4)
MATH	471	Numerical Analysis II (4)
MATH	480	History of Mathematics (3)

STAT 354, STAT 455 and STAT 456 may substitute for MATH 354, MATH 455 and MATH 456, respectively.

Minor

Required Minor. Yes. Any.

MATH MINOR

Core

MATH	121	Calculus I (4)
MATH	122	Calculus II (4)
MATH	247	Linear Algebra I (4)

Restricted Electives

(Choose 7 credits from any courses listed for the BA and BS major).
See Residency Policy.

ACTUARIAL MINOR

Core

FINA	362	Business Finance (3)
FINA	460	Investments (3)
MATH	121	Calculus I (4)
MATH	122	Calculus II (4)

Restricted Electives

Statistics (choose 7-8 credits)

STAT	354	Concepts of Probability & Statistics (4)
STAT	450	Regression Analysis (3)
STAT	455	Theory of Statistics I (4)

Finance (choose 3 credits)

(See Residency Requirement)

FINA	467	Insurance and Risk Management (3)
FINA	480	Options and Futures (3)

Unrestricted Electives

Recommended Courses (choose 0 - 13 credits)

Along with the above courses, the following courses satisfy aspects the VEE (Validation of Educational Experience) of the professional societies associated to actuarial science. Students taking these additional courses may apply them towards becoming certified in the three areas of the VEE: economics, applied statistical methods and corporate finance.

ECON	201	Principles of Macroeconomics (3)
ECON	202	Principles of Microeconomics (3)
MATH	223	Calculus III (4)
STAT	458	Categorical Data Analysis (3)

COURSE DESCRIPTIONS

MATH 094 (4) Essential Mathematics with Elementary Algebra

Basic mathematics skills integrating the fundamental operations of whole numbers, integers, fractions, decimals, percents, ratio and proportion with the elementary algebra topics of linear equations and inequalities, graphs, exponents, polynomials and factoring. Credit does not apply toward graduation. P/N only.
Summer

MATH 098 (4) Intermediate Algebra

Topics covered include intermediate study of graphs, systems of linear equations, introduction to functions, linear and nonlinear inequalities, factoring, rational expressions and equations, radicals, and basic quadratic equations. Credit does not apply toward graduation.
P/ N only
Fall, Spring, Summer

MATH 110 (3) Perspectives in Mathematics

A survey of mathematics and its relationship to society, showing its development and evolution to meet the needs of humankind.
Prerequisite: Three years high school algebra/geometry or MATH 098
Fall, Spring, Summer
GE-4

MATH 112 (4) College Algebra

Concepts of algebra (real numbers, exponents, polynomials, rational expressions), equations and inequalities, functions and graphs, polynomial and rational functions, exponential and logarithmic functions, systems of equations and inequalities, matrices and determinants, conic sections, sequences and series, probability, and binomial theorem. Prerequisite: Satisfy Placement Table in this section, or MATH 098 with grade of P. Fall, Spring, Summer
GE-4

MATH 113 (3) Trigonometry

Basic concepts of trigonometry as preparation for college level mathematics and science course work. Topics include concepts of algebra (real numbers, functions, graphs of functions, exponential and logarithmic functions), trigonometric functions, analytic trigonometry, applications of trigonometry, and analytic geometry. Prerequisite: Satisfy Placement Table in this section, or MATH 112 with "C" (2.0) or better.
Fall, Spring, Summer
GE-4

MATH 115 (4) Precalculus Mathematics

This course will cover topics of precalculus mathematics. Topics covered will include functions, graphs of functions, exponential and logarithmic functions, conic sections, systems of equations, and inequalities, matrices, trigonometric functions, circular functions, vectors and complex numbers, induction, series, and probability. Prerequisite: Satisfy Math Placement Table in this section, or grade of P in MATH 098. Fall, Spring, Summer
GE-4

MATH 121 (4) Calculus I

Limits, continuity, the derivative and applications, transcendental functions, L'Hopital's Rule, and development of the Riemann integral. Prerequisite: Satisfy Placement Table in this section, MATH 115 or both MATH 112 and MATH 113 with "C" (2.0) or better.
Fall, Spring, Summer
GE-4

MATH 122 (4) Calculus II

Techniques of integration, applications of integration, improper integrals, numerical integration, the calculus of parametric curves, infinite series and sequences, and vectors in two and three dimensions. Prerequisite: MATH 121 with "C" (2.0) or better or consent
Fall, Spring, Summer

MATH 127 (2) Calculus II for Engineering Technology: Integration

A continuation of the study of calculus from MATH 121 including transcendental functions, L'Hopital's rule, techniques of integration, and vectors in two and three dimensions. Content is intended for students enrolled in any engineering technology program. Credit for both MATH 127 and MATH 122 is not allowed. Prerequisite: MATH 121 with "C" (2.0) or better or consent
Fall

MATH 130 (4) Finite Mathematics and Introductory Calculus

This course develops concepts and skills in algebra and introductory calculus needed to model applications in business, economics, social sciences and life sciences, using polynomials, exponentials, logarithms, linear systems, linear programming, sequences, series, derivatives and integrals.

Prerequisite: Satisfy Placement Table in this section, or grade of "C" (2.0) or better in either MATH 112 or MATH 115.

Fall, Spring, Summer
GE-4

MATH 170 (3) Introduction to Mathematical Software Programming

Students will learn the rudiments of algorithmic processes such as iteration and recursion and implement simple mathematical algorithms in a commonly used mathematical software package. Applications may include graphing, equation solving, numerical approximation, recurrence relations, and generation of mathematical objects such as sets, lists, permutations and trees.

Prerequisite: MATH 121

Fall (On Demand), Spring (On Demand)

MATH 180 (4) Mathematics for Computer Science

This course is an introduction to the mathematical concepts needed in computer science, including sets, logic, representations of numbers, counting techniques, discrete functions, matrices, trees and graphs, and algorithm analysis.

Prerequisite: MATH 112 or equivalent, with "C" (2.0) or better, or consent

Fall
GE-4

MATH 181 (3) Intuitive Calculus

This course presents the concepts of the differential and integral calculus from an intuitive (non-theoretical) point of view. The course emphasis is on the applications of the calculus. Credit for both MATH 181 and MATH 121 is not allowed.

Prerequisite: Satisfy Placement Table in this section, or Math 112 with "C" (2.0) or better.

Spring, Summer
GE-4

MATH 201 (3) Elements of Mathematics I

Nature of mathematics from a problem solving approach using sets, relations, number systems through integers, rational numbers and discrete mathematics.

Prerequisite: Satisfy Placement Table in this section, or Grade of P in MATH 098 or "C" (2.0) or better in MATH 112 or MATH 115.

Fall, Spring
GE-4

MATH 202 (3) Elements of Mathematics II

A continuation of MATH 201, including rational and real number systems, informal geometry and measurement, statistics, and probability.

Prerequisite: MATH 201, with "C" (2.0) or better or consent

Fall, Spring

MATH 203 (3) Elements of Math III

Transformational and Euclidean geometry, coordinate geometry and applications of discrete mathematics.

Prerequisite: MATH 202 with "C" (2.0) or better or consent

Spring

MATH 223 (4) Calculus III

Surfaces, vector-valued functions, partial differentiation, multiple integration, and vector calculus.

Prerequisite: MATH 122 with "C" (2.0) or better, or consent

Fall, Spring

MATH 247 (4) Linear Algebra I

Matrices, determinants, systems of linear equations, vector spaces, linear transformations, and characteristic value problems.

Prerequisite: MATH 122 with "C" (2.0) or better or consent

Fall, Spring, Summer

MATH 290 (4) Foundations of Mathematics

Logic, proof techniques, set theory, relations, functions, cardinality, operations, and an introduction to mathematical structures and number theory.

Prerequisite: MATH 122 with "C" (2.0) or better or consent.

Fall, Spring
GE-2

MATH 293 (1) MAX Scholar Seminar

This class provides MAX scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Cannot be used towards a math major.

Prerequisite: Recipient of a MAX scholarship or instructor consent.

Fall, Spring

MATH 316 (3) Intermediate Analysis

Limits, sequences, continuity, and differentiation of a real valued function of a real variable.

Prerequisite: MATH 223 and MATH 290 with "C" (2.0) or better or consent

Spring

MATH 321 (4) Ordinary Differential Equations

This course presents the theory, computations, and applications of first and second order differential equations and two-dimensional systems.

Prerequisite: MATH 122 with "C" (2.0) or better or consent

Fall, Spring, Summer

MATH 332 (4) College Geometry

This course covers several geometric systems including Euclidean, non-Euclidean, transformational and projective. Other topics studied are topological properties and the relationship between coordinate and synthetic geometry.

Prerequisite: MATH 290 with "C" (2.0) or better or consent

Fall

MATH 345 (4) Abstract Algebra I

An introduction to the theory of groups and rings; including polynomial rings, homomorphisms, isomorphisms, and concepts of normal subgroups, ideals, quotient groups, and quotient rings.

Prerequisite: MATH 290 with "C" (2.0) or better or consent

Fall

MATH 354 (4) Concepts of Probability & Statistics

This is a calculus-based course covering introductory level topics of probability and statistics. It is designed to meet the needs of both the practitioner and the person who plans further in-depth study. Topics include probability, random variables and probability distributions, joint probability distributions, statistical inference (both estimation and hypothesis testing), analysis of variance, regression, and correlation. Same as STAT 354.

Prerequisite: MATH 122 with "C" (2.0) or better or consent

Fall, Spring, Summer

MATH 375 (4) Introduction to Discrete Mathematics

An introduction to the concepts fundamental to the analysis of algorithms and their realization. Topics will include combinatorics, generating functions, recurrence relations, graph theory, and networks.

Prerequisite: MATH 247 and MATH 290 with grade of "C" (2.0) or higher.

Fall, Spring

MATH 398 (0) CPT: Co-Operative Experience

Curricular Practical Training: Co-Operative Experience is a zero-credit full-time practical training experience for one summer and on adjacent fall or spring term. Special rules apply to preserve full-time student status. Please contact an advisor in your program for complete information.

Prerequisite: At least 60 credits earned; in good standing; instructor permission; co-op contract; other prerequisites may also apply.

Fall, Spring, Summer

MATH 402 (4) Introduction to Topology

An introduction to topological spaces and their fundamental properties such as compactness, connectedness, separation properties and countability properties. Continuous functions between topological spaces and common examples of topological spaces are also discussed.

Prerequisite: MATH 290 with grade of "C" (2.0) or higher.

On Demand: Spring

MATH 411 (4) Introduction to Complex Variables

Algebra and geometry of complex numbers, analytic functions, power series, Cauchy's theorem and residue theorem.

Prerequisite: MATH 223 and MATH 290 with "C" (2.0) or better or consent

Spring (Odd Years)

MATH 417 (4) Real Analysis I

The topology of Euclidean spaces, norms, classical inequalities, local and global properties of continuous functions, preservation of compactness and connectedness, sequences in Euclidean space and sequences of functions.

Prerequisite: MATH 223 and MATH 290 with "C" (2.0) or better or consent

Fall

MATH 418 (3) Real Analysis II

A continuation of MATH 417. The course may include topics from metric spaces, Riemann-Stieltjes integration, differentiation in Euclidean space, sequences and series of functions, approximation theorems, implicit and inverse function theorems, equicontinuity, and mapping theorems.

Prerequisite: MATH 417 with "C" (2.0) or better or consent

On Demand: Spring

MATH 422 (4) Partial Differential Equations

This course presents the theory, computations, and applications of partial differential equations and Fourier series.

Prerequisite: MATH 223 and MATH 321 with "C" (2.0) or better or consent

Spring (Even Years)

MATH 425 (4) Mathematical Modeling

This course presents topics from mathematical analysis of both discrete and continuous models taken from problems in the natural sciences, economics and resource management.

Prerequisite: MATH 223 and MATH 247 with "C" (2.0) or better or consent

Spring (Odd Years)

MATH 428 (4) Linear Optimization Methods

Simplex method and its variants, duality, sensitivity analysis, interior-point methods, quadratic programming and linear complementarity problems. Applications such as classification problems and game theory with linear optimization software.

Prerequisite: MATH 122, MATH 247

On Demand: Fall, Spring, Summer

MATH 435 (4) Modern Geometry

Geometry of spaces including Euclidean and non-Euclidean and applications of contemporary geometry.

Prerequisite: MATH 332 with "C" (2.0) or better or consent

Fall (On Demand), Spring (On Demand), Summer (On Demand)

MATH 442 (4) Theory of Numbers

Euclidean algorithm, primes, composites, number theoretic functions, congruencies, Diophantine equations, Euler and Fermat theorems, algebraic number fields.

Prerequisite: MATH 345 with "C" (2.0) or better or consent

Spring (Even Years)

MATH 446 (4) Abstract Algebra II

A continuation of MATH 345. The course will include topics from groups, rings, and fields.

Prerequisite: MATH 345 with "C" (2.0) or better or consent

Fall (On Demand), Spring (On Demand), Summer (On Demand)

MATH 447 (3) Linear Algebra II

An in-depth study of linear operators and their related spaces, dimension, rank, matrix representation of linear operators, special matrices, determinants, eigenvectors and eigenvalues.

Prerequisite: MATH 345 with "C" (2.0) or better or consent

Spring

MATH 455 (4) Theory of Statistics I

A mathematical approach to statistics with derivation of theoretical results and of basic techniques used in applications. Includes probability, continuous probability distributions, multivariate distributions, functions of random variables, central limit theorem and statistical inference. Same as STAT 455.

Prerequisite: MATH 223 with "C" (2.0) or better or consent

Fall

MATH 456 (4) Theory of Statistics II

A mathematical approach to statistics with derivation of theoretical results and of basic techniques used in applications, including sufficient statistics, additional statistical inference, theory of statistical tests, inferences about normal models and nonparametric methods. Same as STAT 456.

Prerequisite: MATH 455 / STAT 455 with "C" (2.0) or better or consent

Spring

MATH 460 (3) Actuarial Applications in Probability

This course applies probabilistic methods to problems encountered in actuarial science that prepares students for the Society of Actuaries Exam P/1.

Prerequisite: (MATH 354, STATS 354, MATH 455 or STAT 455) and MATH 223

Fall (On Demand), Spring (On Demand), Summer (On Demand)

MATH 461 (4) Mathematical Theory of Interest

This course covers the theory of interest portion of Exam FM/2 of the Society of Actuaries. Topics include time value of money, measurement of interest, annuities certain, arithmetic and geometric annuities, amortization schedules and sinking fund, bonds and other securities, yield rates, and interest rate immunization.

Prerequisite: MATH 223

Fall (On Demand), Spring (On Demand), Summer (On Demand)

MATH 470 (4) Numerical Analysis I

This course provides an introduction to techniques and analysis involved with solving mathematical problems using technology. Topics included are errors in computation, solutions of linear and nonlinear equations, numerical differentiation and integration, and interpolation.

Prerequisite: MATH 122, MATH 247 with "C" (2.0) or better or consent

Fall

MATH 471 (4) Numerical Analysis II

This course is a continuation of MATH 470. Topics included are the algebraic eigenvalue problem, least squares approximation, solutions of systems of nonlinear equations, numerical solutions of ordinary differential equations.

Prerequisite: MATH 470 and MATH 223 with "C" (2.0) or better or consent

On Demand: Spring

MATH 475 (4) Advanced Mathematical Software Programming

Students will learn fundamental concepts of computer programming and write software to implement a variety of mathematical algorithms, manipulate large amounts of data, test conjectures, and make abstract mathematical concepts concrete. Programming concepts include input versus output, data structures, local and global variables, switch statements, iteration, recursion, halting conditions, modularity, debugging, and algorithm analysis. Programming projects may vary with instructor, but could include topics from enumerative combinatorics, graph theory, group theory, linear algebra, and number theory.

Prerequisite: Math 345 and Math 375 with a "C"(2.0) or better, and senior standing or consent

Fall, Spring

MATH 480 (3) History of Mathematics

The development of selected topics from before the Hellenistic time period to the late twentieth century. Familiarity with the content of HIST 180V is beneficial.

Prerequisite: MATH 345 with "C" (2.0) or better or consent

Spring (Odd Years)

MATH 483 (3) Advanced Viewpoint of 5-8 School Mathematics

Advanced viewpoint of mathematics content and learning theories, teaching strategies, reading strategies, assessments, and planning, teaching and reflecting on grades 5-8 mathematics. Field experiences in grades 5-8 mathematics classroom required.

Prerequisite: MATH 290 with "C" (2.0) or better or consent

Spring

MATH 484 (3) Technology in 5-12 School Mathematics

Numerical, verbal, symbolic and graphical representations of quantitative relationships, concatenations in written mathematics, problem solving, dynamic geometry, perspective drawing, parametric equations, geometric probability, transition matrices, statistics and calculus using technology.

Prerequisite: MATH 290 with "C" (2.0) or better or consent

Fall

MATH 485 (3) Teaching Secondary School Mathematics

Learning theories, teaching strategies, assessments and planning, teaching and reflecting on secondary (grades 9-12) school mathematics. Field experiences in grades 9-12 mathematics classroom required.

Prerequisite: MATH 290 with "C" (2.0) or better or consent

Fall

MATH 487 (1) Teaching Experiences in Mathematics

Student will work with an experienced member of the faculty in teaching a college mathematics course.

MATH 488 (1-3) Seminar

A course of study in which a group of students study a topic by examining results through reports and discussions. May be repeated for credit on each new topic.

MATH 490 (1-4) Workshop

A short course devoted to a specific mathematical topic. May be repeated for credit on each new topic.

MATH 491 (1-4) In-Service

A course designed to upgrade the qualifications of persons on-the-job. May be repeated for credit on each new topic.

MATH 492 (3) Mathematics Capstone Experience

This course is designed to allow undergraduate students an opportunity to integrate their undergraduate mathematics experiences by engaging each student in working on a problem in applied or theoretical mathematics. Content will vary by semester. Because of the breadth of mathematics topics needed for successful completion of the course, students need to have senior standing.

Prerequisite: Two of the following: MATH 316, MATH 321, MATH 345, MATH 375 and senior standing (or permission of the instructor). Course can also be taken independent study with permission of a cooperating faculty member.

On Demand: Fall

MATH 492W (3) Mathematics Capstone Experience

This course is designed to allow undergraduate students an opportunity to integrate their undergraduate mathematics experiences by engaging each student in working on a problem in applied or theoretical mathematics. Content will vary by semester. Because of the breadth of mathematics topics needed for successful completion of the course, students need to have senior standing.

Prerequisite: Two of the following: MATH 316, MATH 321, MATH 345, MATH 375 and senior standing (or permission of the instructor). Course can also be taken independent study with permission of a cooperating faculty member.

Fall

MATH 493 (1) MAX Scholar Seminar

This class provides MAX scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Students will be required to participate in mentoring of lower division MAX scholarship recipients and provide written and oral presentations of various topics during the semester.

Prerequisite: Recipient of a MAX scholarship or instructor consent

Fall, Spring

MATH 495 (1-4) Selected Topics

A course in an area of mathematics not regularly offered. May be repeated for credit on each new topic.

MATH 498 (1-12) Internship

Provides a student the opportunity to gain expertise and experience in a special field under the supervision of a qualified person.

MATH 499 (1-4) Individual Study

Independent individual study under the guidance and direction of a faculty member in mathematics. Special arrangements must be made with an appropriate faculty member. May be repeated for credit on each new topic.