

## MATHEMATICS

### Mathematics

College of Science, Engineering & Technology  
Department of Mathematics and Statistics  
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Chair: Larry M. Pearson

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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 courses in mathematics are organized with the needs of three groups of students in mind: (1) those interested in mathematics as a major field of study who may be planning more advanced study in the field, preparing to teach or intending to use their skill in business, industry or government; (2) those needing mathematics primarily as a tool in other disciplines (some special courses and sequences are provided to better meet this need); and (3) those interested in the logical and cultural aspects of mathematics as an element in their general education.

Admission to Major is granted by the department. Minimum university admission requirements are:

- a minimum of 32 earned semester credit hours.
  - a minimum cumulative GPA of 2.00 (C), including 8 credits in mathematics, MATH 121 or higher, with a 2.5 GPA in mathematics.
- Contact the department for application procedures.

#### MATH BA, BS

Required for Major (Core, 27-28 credits):

MATH 121 Calculus I (4)  
MATH 122 Calculus II (4)  
MATH 223 Calculus III (4)  
MATH 247 Linear Algebra I (4)  
MATH 290 Foundations of Mathematics (4)

Choose two from the following:

MATH 316 Intermediate Analysis (3)  
MATH 345 Abstract Algebra I (4)  
MATH 375 Intro to Discrete Mathematics (4)

Required for Major (Electives, 15 credits):

Choose a minimum of 15 credits from the following; at least three (3) credits must be at the 400 level:

MATH 316	MATH 321	MATH 332	MATH 345	MATH 354
MATH 375	MATH 392	MATH 411	MATH 417	MATH 418
MATH 422	MATH 425	MATH 435	MATH 442	MATH 446
MATH 447	MATH 455	MATH 456	MATH 470	MATH 471
MATH 480	MATH 496			

Required for Bachelor of Arts (BA) degree ONLY:  
Language (8)

Required Minor. Yes. Any.

#### MATH BS TEACHING

Required for Major (Core, 50 credits):

MATH 121 Calculus I (4)  
MATH 122 Calculus II (4)

MATH 223 Calculus III (4)  
MATH 247 Linear Algebra I (4)  
MATH 290 Foundations of Mathematics (4)  
MATH 316 Intermediate Analysis (3)  
MATH 332 College Geometry (4)  
MATH 345 Abstract Algebra I (4)  
MATH 354 Concepts of Probability and Statistics (3)  
MATH 375 Intro. to Discrete Mathematics (4)  
MATH 480 History of Mathematics (3)  
MATH 483 Advanced Viewpoint of 5-8 School Mathematics (3)  
MATH 484 Technology in 5-12 School Mathematics (3)  
MATH 485 Teaching Secondary School Mathematics (3)

Required for Major (Professional Education, 30 credits):

See the SECONDARY EDUCATION section for admission requirements to Professional Education and a list of required professional education courses.

Required Minor: No.

#### MATH BA, BS MINOR

Required for Minor (Core, 12 credits):

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

Required for Minor (Electives, 7 credits):

Choose 7 credits from any courses listed for the BA and BS major.

#### POLICIES/INFORMATION

GPA Policy. Mathematics majors or minors must earn a grade of C or better in all courses applied to the major or minor.

P/N Grading Policy. Not more than one-fourth of the credits in mathematics courses numbered 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, 498, and 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, 112, 113, 115, or 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 after completing MATH 455 or STAT 455.

Placement Information for Mathematics Course Enrollment. Students may register for mathematics courses at several different levels, depending on their background in mathematics. Verification of adequate preparation is required for enrollment in MATH 112, 113, 115, 121, or higher. Students planning to register for these courses must achieve a minimum score on the mathematics placement exam (administered at orientation) or a minimum score on the ACT sub-score in math. New transfer students may base their course enrollment on achievement in previously completed pre-requisite courses in mathematics. For further information about placement and mathematics course pre-requisites, students may contact the Department of Mathematics and Statistics or the College's Student Relations Coordinator.

Advising Suggestions. A person with a major in mathematics is encouraged to have a significant concentration in an area of recognized application. By proper selection of electives and willingness to exceed the required minimum number of credits for graduation, a student may earn a second major in fields such as accounting, business administration, biology, chemistry, computer science, economics, environmental sciences, geography, or physics.

#### 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

F, S

**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 mankind.

Pre: Three years high school algebra/geometry or MATH 098 F, S

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.

Pre: Must achieve a score of 18 or better on the MnSCU Math Readiness Test, or have achieved an ACT Math subscore of 19 or higher, or successful completion of MATH 098. F, S

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.

Pre: Must achieve a score of 18 or better on the MnSCU Math Readiness Test, or have achieved an ACT Math subscore of 19 or higher, or successful completion of MATH 098. F, S

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.

Pre: Must achieve a score of 19 or better on the MnSCU Math Readiness Test, or have achieved an ACT Math subscore of 20 or higher, or successful completion of MATH 098. F, S

GE-4

**MATH 121 (4) Calculus I**

Limits, continuity, the derivative and applications, and the integral and applications. Pre: MATH 115 or both 112 and 113 with C or by Math Placement Score (see Mathematics Placement Policy). F, S

GE-4

**MATH 122 (4) Calculus II**

Transcendental functions, L'Hopital's rule, techniques of integration, sequences and series, parametric equations and polar coordinates, and vectors in two and three dimensions.

Pre: MATH 121 with C or better or consent F, S

**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.

Pre: MATH 121 with C or better or consent S

**MATH 128 (2) Calculus II for Engineering Technology: Infinite Series**

A continuation of the study of calculus from MATH 127 including infinite series, parametric equations, and polar coordinates. Content is intended for students enrolled in any engineering technology program. Credit for both MATH 128 and MATH 122 is not allowed.

Pre: MATH 127 with C or better or consent S

**MATH 130 (3) Finite Math and Its Applications**

This course is an introduction to the mathematical concepts needed in business, the social sciences, and the life sciences including problem solving and linear models, linear algebra, linear programming, consumer mathematics, probability and statistics, and decision making.

Pre: Three years of high school mathematics

GE-4

**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.

Pre: MATH 112 or equivalent F, S

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 to the fields of business and economics.

Pre: MATH 112 F

GE-4

**MATH 184 (3) Mathematical Reasoning**

Designed to increase a student's ability to reason quantitatively and to communicate mathematics effectively through verbal, graphical, and symbolic forms. The acquisition of both mathematical skills and higher-order thinking are learning outcomes. Students will learn how technology can be used to solve mathematical problems. An integral part of this course is student interpretation and evaluation of real-data models and contemporary applications. Students will learn modeling strategies and relevant historical perspectives of mathematics.

Pre: Three years of high school mathematics

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.

Pre: Must achieve a score of 18 or better on the MnSCU Math Readiness Test, or have achieved an ACT Math subscore of 19 or higher, or successful completion of MATH 098. F, S

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.

Pre: MATH 201 F, S

**MATH 223 (4) Calculus III**

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

Pre: MATH 122 with C or better, or consent F, S

**MATH 247 (4) Linear Algebra I**

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

Pre: MATH 122 F, S

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### MATH 290 (4) Foundations of Mathematics

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

Pre: MATH 247 F, S

### MATH 303 (3) Elements of Math III

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

Pre: MATH 202 S

### MATH 316 (3) Intermediate Analysis

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

Pre: MATH 223 and 290 S

### 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.

Pre: MATH 122 F, S

### 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.

Pre: MATH 290 F

### 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.

Pre: MATH 290 F

### MATH 354 (3) 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.

Pre: MATH 122 F, S

### 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.

Pre: MATH 180 or 290 or consent F, S

### MATH 392 (4) Topology of Euclidean Spaces

Metric spaces, topology of metric spaces, continuity, compactness in metric spaces, and Euclidean  $n$ -space.

Pre: MATH 290

### MATH 411 (4) Introduction to Complex Variables

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

Pre: MATH 223 and 290 ALT-S

### MATH 417 (3) Real Analysis I

Limits and continuity, sequences and series, differentiation and integration.

Pre: MATH 223 and 290 F

### MATH 418 (3) Real Analysis II

Topology of Euclidean spaces, continuous functions, sequences of functions and differentiable mappings.

Pre: MATH 417

### MATH 422 (4) Partial Differential Equations

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

Pre: MATH 223 and 321 ALT-S

### 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.

Pre: MATH 223 and 247 ALT-S

### MATH 435 (4) Modern Geometry

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

Pre: MATH 332 or consent

### MATH 442 (4) Theory of Numbers

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

Pre: MATH 345

### MATH 446 (4) Abstract Algebra II

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

Pre: MATH 345 S

### 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.

Pre: MATH 345 or consent F

### 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.

Pre: MATH 223 F

### 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

Pre: MATH/STAT 455

### 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.

Pre: MATH 122, 247, and familiarity with a programming language F

### 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.

Pre: MATH 470 and 223

### 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 180 is beneficial.

Pre: MATH 345 F

### 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.

Pre: MATH 290 S

### 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.

Pre: MATH 290 F

**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.

Pre: MATH 290 F

**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 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 496 (3) Mathematical Logic**

Propositional logic, first and second order logic, completeness, consistency, models of theories, Godel's Incompleteness theorem.

Pre: MATH 345 and PHIL 411

**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.