

Mathematics (MATH)

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The Department of Mathematics offers major programs that can satisfy a variety of student interests and careers. Majors in mathematics can prepare themselves for graduate study in mathematics or related areas, for the teaching of mathematics at the secondary school level, for professional school in law or health science, or for the application of mathematics and statistics in science, business, industry and government.

Students majoring in mathematics are encouraged to use elective courses to broaden their background in mathematics or in a related area of special interest. Coursework in biology, chemistry, economics, engineering, finance, geology, physics, psychology and quantitative methods/computer science combines well with a major in mathematics.

Students graduating with a major in mathematics will be able to demonstrate an understanding of the fundamental notions of mathematics, including rigorous proof. They will be able to model and solve real-world problems arising in business and industry. They will be able to effectively communicate, both orally and in writing, mathematical concepts to their peers and to an audience of non-majors. They will be able to learn and apply mathematics on their own through independent study, research and participation in non-class-related lectures.

In all major programs, a student must successfully complete at least 16 credits in mathematics courses numbered 300 and above at the University of St. Thomas.

In addition to the mathematics programs described below, the department has programs to prepare students for careers in actuarial science (see Interdisciplinary Programs) or teacher licensure. A minor in mathematics is available to support majors in many other departments.

Students should see the chair of the Department of Mathematics for advice in selecting courses for a particular purpose. The department offers a number of courses for non-majors to fulfill the mathematics portion of the core curriculum.

Center for Applied Mathematics

Within the Department of Mathematics, the Center for Applied Mathematics provides opportunities for students to work on significant mathematical problems of current interest to business, industry, and government.

Major in Mathematics

- 113 Calculus I (or 108 and 109)
- 114 Calculus II
- 200 Multi-Variable Calculus
- 210 Linear Algebra and Differential Equations
- 317 Real Analysis

Plus one of the mathematics programs below:

Allied requirement for all programs

- QMCS 230 Software Design Using the JAVA Language

Pure Mathematics Program

One of:

- 301 Abstract Algebra I
- 310 Modern Linear Algebra

Plus one of:

- 302 Abstract Algebra II
- 385 Mathematical Methods of Numerical Analysis
- 400 Dynamical Systems and Chaos
- 419 Complex Variables
- 420 Topology

Plus:

eight credits of courses 300 or higher not already taken

Plus one of the following sequences of applications of mathematics:

- ACSC 264 and 464
- ACSC 351 and 352
- ECON 351 and 352 and 418
- MATH 313 and 314
- MATH 315 and 316
- MATH 325 and 450
- PHYS 111 and 112
- QMCS 410 and 411

College of Arts and Sciences – Departments

Applied Mathematics Program

- 300 Differential Equations and Applied Mathematics
- 310 Modern Linear Algebra
- 315 Applied Mathematics and Modeling I
- 316 Applied Mathematics and Modeling II

Plus one of:

- 303 Statistics for the Applied Sciences
- 313 Probability

Plus one of:

- 385 Mathematical Methods of Numerical Analysis
- 419 Complex Variables

Statistics Program

- 310 Modern Linear Algebra
- 313 Probability
- 314 Mathematical Statistics
- 333 Applied Statistical Methods: Regression, Time Series, Forecasting
- 385 Mathematical Methods of Numerical Analysis

Plus:

- QMCS 320 Statistics II

Teacher Licensure

Elementary Education with a Co-major in Science and Mathematics for Elementary Education

Elementary Education with a Specialty in Mathematics (5-8)

Major in Mathematics with a Co-major in Secondary Education (5-12)

See School of Education Department of Teacher Education

Minor in Mathematics

- 113 Calculus I (or 108-109)
- 114 Calculus II

Plus at least one of:

- 200 Multi-Variable Calculus
- 210 Linear Algebra and Differential Equations

Plus:

A minimum of twelve additional credits in courses numbered above 200 (or approved by the department chair)
A student minoring in mathematics must successfully complete a minimum of 8 credits in mathematics numbered 200 and above at St. Thomas.

005 Basic Math Skills

0 credit

This review of arithmetic and elementary algebra is designed to prepare the student to study MATH 100 (Mathematical Sampler) or MATH 101 (Finite Mathematics). The course is designed as a self-directed study experience, with lectures scheduled only during the J-term and summer offerings. The student will have access to textbook explanations and exercises, videos, CD-ROMs and tutors to gain mastery of the material. Appropriate testing is done with the tutors in the Mathematics Resource Center (MaRC). A nominal registration fee is charged.

100 Mathematical Sampler

This survey of basic mathematical concepts includes both modern and historical perspectives. Emphasis is on the development and appreciation of mathematical ideas and their relationship to other disciplines. Topics include, among others: mathematical problem-solving, set theory, graph theory, an introduction to randomness, counting and probability, statistics and data exploration, measurement and symmetry, and recursion. This course satisfies the core curriculum requirement for a core-area course in mathematics and is also recommended as the first course in mathematics for prospective elementary teachers.

Prerequisite: A satisfactory score on the mathematics placement exam

101 Finite Mathematics

Elementary set theory, linear equations and matrices, linear programming, finite probability, applications primarily in business and the social sciences.

Prerequisite: A satisfactory score on the mathematics placement examination

105 Precalculus (108, 109)

The real numbers; basic algebra; analytical treatment of the elementary functions emphasizing the exponential, logarithmic and trigonometric functions and their graphs. (This course is intended as preparation for 113 and does not fulfill a general graduation requirement.)

Prerequisite: A satisfactory score on the mathematics placement examination

108 Calculus With Review I (105, 111, 113)

The first course of a two-course sequence designed to integrate introductory calculus material with the algebraic and trigonometric topics necessary to support that study. Review topics include: number systems, basic algebra, functions, the Cartesian coordinate system, graphing and inverse functions. Calculus topics include limits, continuity, derivatives for algebraic functions, applications of derivatives and more graphing. This course is intended only for students planning to take 109 and does not satisfy the mathematics requirement in the core curriculum. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: A satisfactory score on the mathematics placement examination

109 Calculus With Review II (105, 111, 113)

The second course of a two-course sequence designed to integrate introductory calculus material with the algebraic and trigonometric topics necessary to support that study. Review topics include: exponential and logarithmic functions, trigonometric functions and their inverses and associated graphs. Calculus topics include: derivatives of the transcendental functions, applications of those derivatives and an introduction to integration. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: a grade of C- or better in 108

111 Calculus for Business and Social Science (108, 109, 113)

An introductory course in calculus with motivation and examples drawn from business and the social sciences whenever possible. Does not include the calculus of trigonometric functions.

Prerequisite: a grade of C- or above in 105 or a satisfactory score on the mathematics placement examination. (Four years of high school mathematics, including college algebra, also are recommended as background for this course.) Students intending to continue in calculus are strongly advised to take 113.

113 Calculus I (108, 109, 111)

An introductory course in calculus: limits; derivatives and integrals of algebraic, exponential, logarithmic and trigonometric functions of one real variable; applications primarily in the natural sciences. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: a grade of C- or above in 105 or a satisfactory score on the mathematics placement examination. (Four years of high school mathematics, including college algebra and trigonometry, also are recommended as background for this course.)

114 Calculus II

Techniques of integration; applications of integration; infinite series; L'Hospital's rule; improper integrals. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: a grade of C- or above in 113 or 109 (or 111, with permission of the department chair)

121 Structures of Elementary Mathematics

An examination of the mathematical underpinnings of the elementary school curriculum with an emphasis on the understanding of mathematical concepts. Topics will include foundations of integer and rational arithmetic, notions of place-value and base, number sense and estimation, functions and their applications, Euclidean geometry, and mathematical problem-solving. This course satisfies the core curriculum requirement for the third course in the Natural Sciences and Mathematical and Quantitative Reasoning, and is also recommended as the second course in mathematics for prospective elementary teachers.

Prerequisite: 100

128 Introduction to Discrete Mathematics

A survey of basic discrete mathematical concepts. Topics include: Boolean algebra, logic, analysis of algorithms, mathematical induction and matrices. Focus on applications to computer science.

Prerequisite: 111 or 113 or 109 (may be taken concurrently with consent of the instructor)

200 Multi-Variable Calculus

Vector algebra in two and three dimensions, partial derivatives, multiple integrals, line integrals, surface integrals, Green's Theorem, Stoke's Theorem, divergence theorem. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: a grade of C- or higher in 114

210 Linear Algebra and Differential Equations

The course will introduce the student to linear algebra, differential equations and applications of linear algebra to differential equations. Topics to be covered will include: vector spaces, matrices, determinants, eigenvalues and eigenvectors, linear transformations, systems of ordinary differential equations, and applications to science and engineering. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: a grade of C- or higher in 114

College of Arts and Sciences – Departments

259 Elements of Geometry and Statistics

Intended for elementary education majors who plan a specialization in mathematics for grades 5-8. Includes intermediate concepts in geometry and statistics essential for a middle school teacher of mathematics. Topics will include: axiomatic systems of geometry with emphasis on Books I and VI of Euclid's Elements; an introduction to non-Euclidean geometry; geometric and inductive reasoning, with applications; introduction to geometric probability and the geometric display of data; organization and analysis of data sets; statistical support of decisions, including applications in education; prediction; the role of randomness in both formal and empirical probability.

Prerequisites: 100 and 121

295, 296 Topics

2 credits

297, 298 Topics

The subject matter of these courses, announced in the annual *Class Schedule*, will vary from year to year, but will not duplicate existing courses. See the description of these courses at the beginning of the "Curricula" section of this catalog.

300 Differential Equations and Applied Mathematics

Linear ordinary differential equations and systems; standard methods of solution; Laplace transforms; series solution; introduction to nonlinear differential equations and dynamical systems. Models and applications in the physical, biological, behavioral, and social sciences.

Prerequisites: 200 and 210 or permission of the department chair

301 Abstract Algebra I

Properties of sets, relations and mappings; introduction to groups, rings and fields. Offered in fall semester.

Prerequisite: 210

302 Abstract Algebra II

Topics in modern algebra with applications. Includes material selected from the theory of groups, rings, and fields; linear algebra; Boolean algebra and discrete structures.

Prerequisite: 301

303 Statistics for the Applied Sciences (313, 314)

Probability, Estimation, Hypothesis Testing, Analysis of Variance, Regression Analysis, Topics selected from Experimental Design, Statistical Process Control, Non-Parametric Methods, Factor Analysis as time permits. This course fulfills the second-level Computer Competency requirement in the core curriculum.

Prerequisite: 200

310 Modern Linear Algebra

Linear algebra and applications. Topics include linear equations, matrix theory, linear spaces, linear mappings, canonical forms, and inner product spaces. Applications chosen from such topics as numerical linear algebra, least squares, hermitian and positive definite matrices, and electrical networks.

Prerequisite: 210

313 Probability (303)

Probability theory in discrete and continuous sample spaces; random variables and distribution functions; moments; the moment-generating function; functions of random variables; law of large numbers; central limit theorem. Offered in fall semester.

Prerequisites: 200

314 Mathematical Statistics (303)

Populations and random sampling; sampling distributions. Theory of statistical estimation; criteria and methods of point and interval estimation. Theory of testing statistical hypotheses; non-parametric methods. Offered in spring semester.

Prerequisite: 210 and 313

315 Applied Mathematics and Modeling I

This is a topics course in applied mathematics offered through the Center for Applied Mathematics (CAM). Course content will be drawn from areas of applied mathematics, including: mathematical analysis of data, database theory, discrete and continuous modeling, simulation, applied statistics, coding theory, expert systems, neural network analysis, signal processing, optimization theory, and wavelet theory. Students will work in teams on projects of current interest in applied mathematics.

Prerequisites: 200 and 210, or permission of instructor

316 Applied Mathematics and Modeling II

This is a second topics course in applied mathematics offered through the Center for Applied Mathematics (CAM). It does not necessarily require 315 as a prerequisite. Course content will be drawn from the topics listed under MATH 315. Students will work in teams on projects of current interest in applied mathematics.

Prerequisites: 200 and 210, or permission of instructor

317 Real Analysis

Topology of the real numbers. Functions of one real variable. Rigorous development of continuity and uniform continuity; differentiability; uniform convergence. Sequences and series. Offered fall semester.

Prerequisites: 200 and 210

325 Geometry

Axioms for geometries; geometrical transformations and their invariants; non-Euclidean geometries; additional topics. Offered in spring semester.

Prerequisites: 200 and 210 or permission of the instructor

333 Applied Statistical Methods: Regression, Time Series, Forecasting

Regression and exponential smoothing methods; Stochastic Time Series: auto- and cross-correlation, autoregressive moving average models; application to forecasting.

Prerequisites: 303 or 314 or permission of instructor

385 Mathematical Methods of Numerical Analysis

Rigorous mathematical treatment of standard topics in numerical analysis including solutions to linear and non-linear systems, interpolation, numerical integration and differentiation, differential equations, and iterative techniques in matrix algebra. This course provides a theoretical foundation for the numerical solution of mathematical problems. Offered in spring semester.

Prerequisites: 317 and QMCS 230 or permission of instructor

400 Dynamical Systems and Chaos

An introduction to discrete and continuous dynamical systems and applications with topics including: iterated mappings in one and two dimensions, phase-plane theory, nonlinear differential equations, and chaos. Additional topics will be chosen from among bifurcations, stability, attractors, Lyapunov functions, Julia sets and Mandelbrot sets.

Prerequisite: 300 or 317 or permission of instructor

419 Complex Variables

Analytic functions; theorems of Cauchy; Laurent series; residue calculus; entire and meromorphic functions; conformal mapping.

Prerequisite: 317

420 Topology

Properties of Euclidean spaces; general spaces; mappings; separation properties; connectedness; compactness; metrizable spaces.

Prerequisite: 317

450 Advanced Mathematics: Exploration and Exposition

This course gives students a sense of the history, applicability and currency of one or more mathematical ideas and serves as a capstone mathematics course for students seeking to teach secondary mathematics. In the course, students make substantial oral and written presentations on topics carefully selected to have a strong relationship to secondary school mathematics. Topics are included from discrete mathematics and from continuous mathematics. Students use publications, e.g. *The American Mathematical Monthly*, *Mathematics Magazine*, *Mathematical Intelligencer* and *Scientific American*, as well as standard texts, as sources for their work.

Prerequisite: one of 301 or 317 with concurrent registration in the other; senior or graduate standing and declared intent to complete secondary licensure in mathematics. Other students having the course prerequisites may be admitted, but it is their responsibility to determine the relationship of this course to their program of study.

475, 476 **Experiential Learning** 20 credits

477, 478 **Experiential Learning**

See the description of these courses at the beginning of the "Curricula" section of this catalog.

483, 484 **Seminar** 2 credits

485, 486 **Seminar**

See the description of these courses at the beginning of the "Curricula" section of this catalog.

487, 488 **Topics** 2 credits

489, 490 **Topics**

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491, 492 **Research** 2 credits

493, 494 **Research**

See the description of these courses at the beginning of the "Curricula" section of this catalog.

495, 496 **Individual Study** 2 credits

497, 498 **Individual Study**

See the description of these courses at the beginning of the "Curricula" section of this catalog.