

MATHEMATICS

<http://www.math.miami.edu>

Dept. Code: MTH

Educational Objectives

The aim of our mathematics degree programs is to provide students with a core knowledge of mathematics essential to the understanding of science and other disciplines. Students should gain substantial problem solving and critical reasoning skills and should develop an understanding of the conceptual underpinnings of mathematics. The knowledge gained through these programs should provide the necessary background in mathematics for those students planning to go on to graduate study in mathematics and related fields. This knowledge should also prepare those students who will be immediately entering careers in science, business, education or other fields which are increasingly making use of mathematics.

Degree Programs

- Bachelor of Arts and Bachelor of Science

Major

The requirements for a major in mathematics (<http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/mathematics/mathematics-ba-bs/>) vary according to the objectives of the student. There are **seven courses** required of all mathematics majors.

An **additional four courses** are required, selected from one of the following track options:

- Core Mathematics
- Applied Analysis
- Computational Mathematics
- Probability and Statistics
- Secondary School Teaching
- Mathematical Economics

Writing Requirement

In order to satisfy the College of Arts and Sciences writing requirement, students majoring in mathematics must obtain writing credit in one of the following courses: MTH 433, MTH 461, MTH 502, MTH 504, MTH 520, MTH 533, MTH 561, and in three more writing courses from other departments.

Minor

A student seeking a minor in mathematics (<http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/mathematics/mathematics-minor/>) must have credit for a **calculus sequence**: MTH 161-MTH 162 or MTH 171-MTH 172.

In addition, a minor in mathematics requires **three courses** from a list of approved courses for the minor. (<http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/mathematics/mathematics-minor/>) All three courses must be taken in the Department of Mathematics, University of Miami. A grade of C- or better is required for each of the three courses applied toward the minor and the quality point average for the three courses must be 2.5 or above.

Departmental Honors

Requirements for Departmental Honors in Mathematics (<http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/mathematics/mathematics-ba-bs/#curriculumtext>):

The student must complete **three sequences** from a list of approved two-course sequences. The student must attain at least a B in each course used to fulfill this requirement. In addition, the student must attain at least a 3.5 average over all courses counted toward the mathematics major and an overall (university-wide) average of at least 3.3.

For requirements leading to the Master of Arts, Master of Science, or Doctor of Philosophy degrees, with a major in mathematics, see the Bulletin of the Graduate School (<http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/>).

Dual BS/MS Degree

- Five-Year BS Math/MS Math Finance (<http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/mathematics/mathematics-bs-ms/>)

MTH 099. Intermediate Algebra. 3 Credit Hours.

Real number operations, polynomials, factoring, rational numbers and rational expressions. Cannot be used to fulfill the 120 credits required for graduation.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 101. Algebra for College Students. 3 Credit Hours.

Algebraic operations and properties of the real numbers; linear and quadratic equations and inequalities; polynomials and factoring; rational expressions; radical expressions; graphs of lines; systems of linear equations.

Requisite: SAT Math Section Score \geq 550 or Math ACT Score \geq 22 or ALEKS score \geq 40 or passing grade in MTH 099.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 105. Algebra and Trigonometry. 5 Credit Hours.

An intensive course in algebra and trigonometry as covered in MTH 107-108, but without analytic geometry.

Requisite: SAT Math Section Score \geq 600 OR Math ACT Score \geq 25 OR ALEKS score \geq 55 OR passing grade in MTH 101 OR for students admitted as "Test Optional" overall high school GPA 3.3 or higher and B+ or higher in HS Precalculus.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 107. Precalculus Mathematics I. 3 Credit Hours.

Algebraic operations; equations and inequalities; complex numbers; functions and their graphs; polynomial, rational, exponential, and logarithmic functions; inverse functions; systems of non-linear equations.

Requisite: SAT Math Section Score \geq 600 OR Math ACT Score \geq 25 OR ALEKS score \geq 55 OR passing grade in MTH 101 OR for students admitted as "Test Optional" overall high school GPA 3.3 or higher and B+ or higher in HS Precalculus.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 108. Precalculus Mathematics II. 3 Credit Hours.

Trigonometric functions, identities and equations, applications involving vectors, systems of nonlinear equations and inequalities and analytic geometry.

Requisite: SAT Math Section Score \geq 650 OR Math ACT Score \geq 28 OR ALEKS score \geq 65 OR a passing grade in MTH 107 OR for students admitted as "Test Optional" overall high school GPA 3.3 or higher and B+ or higher in HS Calculus.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 113. Finite Mathematics. 3 Credit Hours.

Sets, logic, counting techniques, elementary probability and statistics, mathematics in finance, linear programming, algebraic structures, symmetry. The selection of topics may vary by instructor. Intended for BA students.

ALEKS score \geq 65 OR SAT Math Section Score \geq 650 OR ACT Math Score \geq 28 OR Passing Grade in MTH101 or MTH107 OR for students admitted as "Test Optional" overall high school GPA 3.3 or higher and B+ or higher in HS Calculus.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 130. Introductory Calculus. 3 Credit Hours.

A one-semester survey of the fundamental principles of calculus, functions, limits, derivatives, definite integrals, applications. Not for students planning further study of calculus beyond this course.

Requisite: ALEKS score \geq 65 or SAT MTH score \geq 630 or SAT MTH Section score \geq 650 or ACT score \geq 28 or AP Calculus AB score of 3 or passing grade in MTH 107 OR for students admitted as "Test Optional" overall HS GPA 3.3 or higher and B+ or higher in HS Cal.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 133. Games and Strategies. 3 Credit Hours.

A mathematical introduction to the theory of games, strategies, and optimal responses. Primarily intended for students in a B.A. program.

Prerequisite: MTH 113 or MTH 130.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 140. Calculus Concepts with Foundations A. 4 Credit Hours.

Tools from algebra and trigonometry for calculus. Functions and graphs, limits and continuity, the derivative and applications.

Requisite: ALEKS score ≥ 65 OR SAT MATH ≥ 630 OR SAT MATH SECTION ≥ 650 OR ACT ≥ 28 OR AP Calculus score of 3 OR for students admitted as "Test Optional" overall HS GPA 3.3 or higher and B+ or higher in HS Calculus.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 141. Calculus Concepts with Foundations B. 4 Credit Hours.

Tools from algebra, trigonometry, and analytic geometry for calculus. Further aspects of differentiation. Antiderivatives, definite integrals, and their applications.

Prerequisite: MTH 140. Min Grade C-.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 151. Calculus I for Engineers. 5 Credit Hours.

Analytic geometry, limits and continuity, derivatives, the definite integral, and applications relevant to engineering. Intended for students taking PHY 205 concurrently.

Requisite: SAT Math Section Score ≥ 730 OR Math ACT Score ≥ 31 OR ALEKS score ≥ 76 OR C- or higher in MTH 105 or MTH 108.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 161. Calculus I. 4 Credit Hours.

Limits and continuity, derivatives and applications, the definite integral and applications.

Requisite: ALEKS score ≥ 76 or SAT MATH score ≥ 700 or SAT MATH SECTION ≥ 730 or ACT score ≥ 31 or score of 4 AP Calculus (AB) or score of 3 in AP Calculus (BC) or a C- or higher in MTH 108.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 162. Calculus II. 4 Credit Hours.

Transcendental functions, methods of integration, improper integrals, infinite series, polar coordinates, and introduction to differential equations.

Prerequisite: MTH 141 or MTH 151 or MTH 161 or MTH 171.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 171. Calculus I. 4 Credit Hours.

The theory of limits, the derivative and the definite integral, techniques and applications. The sequence MTH 171-172 is more conceptually-oriented than MTH 161-162.

Requisite: Prism Program.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 172. Calculus II. 4 Credit Hours.

Continuation of MTH 171. Additional topics on the derivative and definite integral, improper integrals, infinite series, and introduction to differential equations.

Prerequisite: MTH 171.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 210. Introduction to Linear Algebra. 3 Credit Hours.

Vectors, matrix algebra, systems of linear equations, and related geometry in Euclidean spaces. Fundamentals of vector spaces, linear transformations, determinants, eigenvalues, and eigenspaces.

Pre/Corequisite: MTH 162 or MTH 172.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 211. Calculus III. 3 Credit Hours.

Vectors in space, partial differentiation, multiple integration.

Prerequisite: MTH 162 or MTH 172. Requisite: Not open to students with credit in MTH 310 or MTH 433 or MTH 533.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 224. Introduction to Probability and Statistics. 3 Credit Hours.

Probability distributions, random variables, expectation and variance, point estimation, interval estimation, testing of hypotheses, analysis of variance.

Pre/Corequisite: MTH 162 or MTH 172.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 230. Introduction to Abstract Mathematics. 3 Credit Hours.

Fundamentals of set theory, logic and methods of mathematical proof.

Pre/Corequisite: MTH 162 or MTH 172.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 309. Discrete Mathematics I. 3 Credit Hours.

Mathematical methods of Computer Science and Computer Engineering. Mathematical reasoning, sets, relations, functions, Boolean algebra, combinatorics, graphs.

Prerequisite: MTH 141 or MTH 151 or MTH 161 or MTH 171.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 310. Multivariable Calculus. 3 Credit Hours.

Equations of curves, surfaces, solids; vector differential calculus; integration of scalar valued functions. Applications. Intended for mathematics majors.

Prerequisite: MTH 210 and MTH 162 or MTH 172. Requisite: Not open to students with credit in MTH 433 OR MTH 533.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

MTH 311. Introduction to Ordinary Differential Equations. 3 Credit Hours.

Theory and applications of first-order differential equations. Theory and applications of higher order linear equations and first order linear systems, including matrix methods.

Prerequisite: MTH 162 or MTH 172.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

MTH 320. Introduction to Numerical Analysis. 3 Credit Hours.

Interpolation, quadrature, numerical solution of algebraic and transcendental equations, and optimization.

Prerequisite: MTH 210 and MTH 211 or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 359. Mathematical Models in Biology and Medicine. 3 Credit Hours.

Fundamentals of the dynamical systems approach to modeling temporal change in biological systems. An introduction to the analysis of mathematical models in biology and medicine with detailed, concrete examples drawn from ecology, cell biology, neuro-science, and physiology.

Prerequisite: MTH 162 or MTH 172.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 433. Advanced Calculus. 3 Credit Hours.

A rigorous and comprehensive treatment of the theoretical concepts of calculus. The real number system; sequences; series; continuity, differentiation, and integration of functions of one variable.

Prerequisite: MTH 230 and MTH 310 or MTH 211. Not open for Students with Credit in MTH 533.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 461. Survey of Modern Algebra. 3 Credit Hours.

Algebraic systems, equivalence classes, groups, rings, fields, unique factorization domains.

Prerequisite: MTH 210 and MTH 230. Requisite: Not open to students with credit in MTH 561.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 471. Directed Readings. 1-3 Credit Hours.

Topics selected from algebra, geometry, analysis, topology.

Components: THI.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 472. Directed Readings. 1-3 Credit Hours.

Topics selected from algebra, geometry, analysis, topology.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 502. History of Mathematics. 3 Credit Hours.

The development of mathematics from its earliest beginnings through the first half of the twentieth century. Numeral systems, geometry, algebra, analysis and set theory.

Prerequisite: 2 Courses in MTH 200 or Higher.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 504. Foundations of Geometry. 3 Credit Hours.

Axiom systems and models of Euclidean and Non-Euclidean geometry.

Prerequisite: MTH 230 or MTH 309.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 505. Theory of Numbers. 3 Credit Hours.

Divisibility, primes; congruences, quadratic residues and reciprocity; Diophantine equations. Applications to cryptography.

Prerequisite: MTH 210 or MTH 504.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 506. Mathematical Logic. 3 Credit Hours.

Logics, truth, proof, logical consequence, model theory, formalization, and computation. Meta-theory of first-order logic, computability theory, and Godel's incompleteness theorems. Related results by Church, Turing, and Tarski. Discussion of their philosophical significance.

Prerequisite: MTH 230.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 510. Linear Algebra. 3 Credit Hours.

Abstract vector spaces, bases and dimensions, linear maps, eigenvalues and eigenvectors, inner product spaces, operators, spectral theorems, canonical forms.

Prerequisite: MTH 210 and MTH 230 or MTH 309.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 512. Elementary Complex Analysis. 3 Credit Hours.

Complex variables; conformal mapping, contour integration.

Prerequisite: MTH 310 or MTH 211.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 513. Partial Differential Equations I. 3 Credit Hours.

Derivation, well posedness, and qualitative properties of initial value and boundary value problems for the heat, wave and Laplace equations. Energy methods, causality, maximum principles, heat kernels, Fourier series, and potential theory.

Prerequisite: MTH 210 and MTH 311 and MTH 211 or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 514. Partial Differential Equations II. 3 Credit Hours.

Continuation of MTH 513. Approximations of solutions, distributions and integral transform methods, spectral theory and scattering. Applications to physical problems. Nonlinear equations and phenomena.

Prerequisite: MTH 513.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 515. Ordinary Differential Equations. 3 Credit Hours.

Linear systems, equilibrium and periodic solutions, stability analysis, bifurcation, phase plane analysis, boundary value problems, applications to engineering and physics.

Prerequisite: MTH 311 and MTH 211 or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 516. Dynamics and Bifurcations. 3 Credit Hours.

Bifurcation of equilibrium and periodic solutions, global theory of planar systems, planar maps, nonlinear vibrations, forced oscillations, chaotic solutions, Hamiltonian systems, applications to engineering and physics.

Prerequisite: MTH 515.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 520. Numerical Linear Algebra. 3 Credit Hours.

Topics from numerical linear algebra including solving systems of equations, LU, QR, and SVD factorizations, eigenvalues and eigenvectors, interactive methods, and applications.

Prerequisite: MTH 320.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 521. Numerical Methods in Differential Equations. 3 Credit Hours.

Numerical solution of ordinary and partial differential equations.

Prerequisite: MTH 320 or MTH 520.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 524. Introduction to Probability. 3 Credit Hours.

Probability spaces, random variables, expectation, limit theorems.

Prerequisite: MTH 224 and MTH 211 or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 525. Introduction to Mathematical Statistics. 3 Credit Hours.

Probability distributions, theory of sampling and hypothesis testing.

Prerequisite: MTH 524.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 527. Theory of Computing. 3 Credit Hours.

Sets, relations, and languages. Automata theory. Basic computability theory. Turing machines. The complexity classes P and NP.

Prerequisite: MTH 309 or MTH 461.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 531. Topology I. 3 Credit Hours.

Set theory, topological spaces, compactness, connectedness, separation properties, quotient spaces, Tychonoff Theorem, compactification, Urysohn Lemma and Tietze Extension Theorem, function spaces.

Prerequisite: MTH 230.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 532. Topology II. 3 Credit Hours.

Differential and topological manifolds, classical groups and associated manifolds, tangent and tensor bundles, vector fields, differential forms, transversality, Sard's theorem, Stokes' Theorem.

Prerequisite: MTH 210 and MTH 531.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 533. Introduction to Real Analysis I. 3 Credit Hours.

Sequences and series in Euclidean space; sequences and series of functions; Fourier series; continuity, differentiation, and integration of functions between Euclidean spaces; implicit and inverse function theorems.

Prerequisite: MTH 230 And MTH 211 Or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 534. Introduction to Real Analysis II. 3 Credit Hours.

Continuation of MTH 533.

Prerequisite: MTH 533.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 542. Statistical Analysis. 3 Credit Hours.

Statistical inference about one or two populations from interval, ordinal and categorical data; analysis of variance; simple and multiple linear regression; designing research studies.

Prerequisite: MTH 210 and MTH 224.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 547. Introduction to Mathematical Finance. 3 Credit Hours.

Models of financial markets. Derivative securities: European and American options. Tools of mathematical finance: binomial trees, martingales, stopping times. Concepts of arbitrage and hedging. Risk-neutral valuation of financial derivatives; the Black-Scholes formula and its applications.

Prerequisite: MTH 224 and MTH 211 or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 551. Introduction to Differential Geometry. 3 Credit Hours.

Geometry of curves and surfaces in Euclidean space. Local space curve theory, intrinsic and extrinsic curvature of surfaces, geodesics, parallelism, and differential forms.

Prerequisite: MTH 210 And MTH 211 Or MTH 310.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 561. Abstract Algebra I. 3 Credit Hours.

Groups; rings; linear algebra; modules.

Prerequisite: MTH 210 and MTH 230.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

MTH 562. Abstract Algebra II. 3 Credit Hours.

Continuation of MTH 561.

Prerequisite: MTH 561.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

MTH 571. Directed Readings in Mathematics. 1-3 Credit Hours.

Readings in special topics.

Components: THI.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 591. Topics in Mathematics. 1-3 Credit Hours.

Topics will vary by semester and will be announced in the schedule of course offerings.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 592. Topics in Mathematics. 1-3 Credit Hours.

Topics will vary by semester and will be announced in the schedule of course offerings.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

MTH 593. Topics in Mathematics. 1-3 Credit Hours.

Topics will vary by semester and will be announced in the schedule of course offerings.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.