MATHEMATICS

http://www.math.miami.edu

Dept. Code: MTH

Degree Programs

The Mathematics Department offers graduate degree programs leading to the:

- Five-Year BS Math/MS Math Finance (http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/mathematics-bs-ms/)
- Master of Arts (http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/mathematics-ma/)
- Master of Science (p. 1)
- Master of Science in Mathematical Finance (p. 1)
- Doctor of Philosophy (p. 1)

Prerequisites and requirements for these degrees are described on the program pages:

Masters Programs in Mathematics

- M.A. in Mathematics (http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/mathematics-ma/)
- M.S. in Mathematics (http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/mathematics-ms/)
- M.S. in Mathematical Finance (http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/mathematical-finance-ms/)

Doctoral Program in Mathematics

- Ph.D. in Mathematics (http://bulletin.miami.edu/graduate-academic-programs/arts-sciences/mathematics/mathematics-phd/)

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 602. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 604. Foundations of Geometry. 3 Credit Hours.
Axiom systems and models of Euclidean and Non-Euclidean geometry
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 605. Theory of Numbers. 3 Credit Hours.
Divisibility, primes; congruences, quadratic residues and reciprocity; Diophantine equations. Applications to cryptography.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 606. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 610. Linear Algebra. 3 Credit Hours.
Abstract vector spaces, bases and dimensions, linear maps, eigenvalues and eigenvectors, inner product spaces, operators, spectral theorems, canonical forms.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 612. Elementary Complex Analysis. 3 Credit Hours.
Complex variables; conformal mapping, contour integration.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 613. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 614. 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 613.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 615. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 616. 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 615.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 620. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 621. Numerical Methods in Differential Equations. 3 Credit Hours.
Numerical solution of ordinary and partial differential equations.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 624. Introduction to Probability Theory. 3 Credit Hours.
Probability spaces, random variables, expectation, limit theorems.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 625. Introduction to Mathematical Statistics. 3 Credit Hours.
Probability distributions, theory of sampling and hypothesis testing.
Prerequisite: MTH 624.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 627. Theory of Computing. 0 Credit Hours.
Sets, relations, and languages. Automata theory. Basic computability theory. Turing machines. The complexity classes P and NP.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 631. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 632. Topology II. 3 Credit Hours.
Differential and topological manifolds, classical groups and associated manifords, tangent and tensor bundles, vector fields, differential forms, transversality, Sard's theorem, Stokes' Theorem.
Prerequisite: MTH 631.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 633. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 634. Introduction to Real Analysis II. 3 Credit Hours.
Continuation of MTH 533.
Prerequisite: MTH 633.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 642. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 643. Statistical Analysis II with Financial Applications. 3 Credit Hours.
Exploratory data analysis. Designing parametric models and assessing their uncertainty. Techniques for resampling. Using multivariate distributions to model financial data; families of copulas. Analyzing time series, including ARIMA and GARCH models.
Prerequisite: MTH 642 or MTH 542.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 645. Optimization Methods. 3 Credit Hours.
Linear optimization: simplex method and simplex tableaus, sensitivity analysis. Quadratic optimization and its applications in finance: risk modeling and portfolio construction. Integer programming techniques, branch and bound method. Dynamic programming - deterministic and probabilistic techniques. Software tools of optimization.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 646. Quantitative Risk Analysis. 3 Credit Hours.
The modeling, measuring, and managing of financial risk using statistical and stochastic methods. Following "Basil Committee on Banking Supervision" risk analysis is now a major issue for the banking Sector. Concepts and methods covered in this course can be applied to managing risk in various areas, but will proceed in the context related to risk analysis and management in finance and insurance.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 647. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 648. Stochastic Calculus with Application to Finance. 3 Credit Hours.
Stochastic calculus developing the basic probabilistic techniques necessary to study analytic models of financial markets. Brownian motion and the stochastic integral, stochastic differential equations, the Black-Scholes formula, Girsanov's theorem and applications to option pricing.
Prerequisite: MTH 647.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 649. Computational Methods of Finance. 3 Credit Hours.
Solutions of nonlinear equations, interpolation, Monte Carlo methods, survey of matrix factorizations, numerical integration and differentiation, and introduction to finite different and finite element methods for PDEs with applications to finance.
Prerequisite: CSC 220 and MTH 643 and MTH 648.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 650. Machine Learning in Quantitative Finance. 3 Credit Hours.
Machine learning techniques for financial applications. Best practices for model selection and construction of big financial data, including regression and classification techniques, and deep learning with application to forecasting financial time series.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 651. 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.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 661. Abstract Algebra I. 3 Credit Hours.
Groups; rings; linear algebra; modules.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MTH 662. Abstract Algebra II. 3 Credit Hours.
Continuation of MTH 561.
Prerequisite: MTH 661.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MTH 682. Blockchain and Cryptocurrency Platforms. 3 Credit Hours.
A detailed introduction to blockchain, the underlying technology that powers cryptocurrency markets. The following topics will be covered: fundamentals of blockchain, decentralization, symmetric and public-key cryptography, Bitcoin network, Bitcoin clients and APIs, smart contracts, Ethereum blockchain, and Ethereum programming.
Prerequisite: MTH 647.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 683. Algorithmic and High-Frequency Trading. 3 Credit Hours.
Topics to be covered: fundamentals of electronic markets and the limit order book, microstructure of financial markets, empirical properties of returns and market activity, introduction to stochastic optimal control and stopping, optimal execution with continuous trading, optimal execution with limit/market orders, pairs-trading and statistical arbitrage, market making, and order imbalance.
Prerequisite: MTH 647.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 686. Topics in Mathematical Finance. 1-3 Credit Hours.
A variety of topics in Mathematical Finance (including data learning, data analysis and quantitative risk management)
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 687. Topics in Mathematical Finance. 1-3 Credit Hours.
Topics in quantitative finance. Possible topics include machine learning techniques in finance, stochastic partial differential equations, mathematics of risk management etc.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 691. 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 692. 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 693. 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 709. Data Security and Crytography. 3 Credit Hours.
Encryption algorithms; cryptographic techniques; access, information flow and inference controls.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 721. Mathematical Probability. 3 Credit Hours.
Development of the measure-theoretic approach to probability. Random variables, central limit theory, laws of large numbers, martingales.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 722. Stochastic Processes. 3 Credit Hours.
Properties of discrete-parameter and continuous-parameter processes. Markov chains and their attributes. Random walks, recurrence, stopping times, strong Markov property, invariant measures. Pure jump continuous-time processes, Poisson processes. Standard Brownian motion and applications.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 733. Real Variables. 3 Credit Hours.
First semester of a two semester sequence: General measure theory, Lebesgue measure and integration, Lp spaces, Fourier series in one and many variables, Fourier transforms, distributions, Sobolev spaces, applications to partial differential equations.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 734. Real Variables. 3 Credit Hours.
Second semester of a two semester sequence: General measure theory, Lebesgue measure and integration, Lp spaces, Fourier series in one and many variables, Fourier transforms, distributions, Sobolev spaces, applications to partial differential equations.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 735. Complex Variables. 3 Credit Hours.
First semester of a two semester sequence: Analytic functions, conformality, Cauchy's Theorem, representation theorems, harmonic functions, calculus of residues, Riemann Mapping Theorem, entire and meromorphic functions, analytic continuation, normal families.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 736. Complex Variables. 3 Credit Hours.
Second semester of a two semester sequence: Analytic functions, conformality, Cauchy's Theorem, representation theorems, harmonic functions, calculus of residues, Riemann Mapping Theorem, entire and meromorphic functions, analytic continuation, normal families.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 741. Algebraic Topology. 3 Credit Hours.
First semester of a two semester sequence: Homotopy and homotopy type, fundamental group, covering spaces, higher homotopy groups, simplicial singular and cellular homology, Eilenberg-Steenrod axioms, cohomology, universal coefficient theorem, products, Kunneth formula, duality theorems for manifolds, computations and applications.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 742. Algebraic Topology. 3 Credit Hours.
Second semester of a two semester sequence: Homotopy and homotopy type, fundamental group, covering spaces, higher homotopy groups, simplicial singular and cellular homology, Eilenberg-Steenrod axioms, cohomology, universal coefficient theorem, products, Kunneth formula, duality theorems for manifolds, computations and applications.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 751. Differential Geometry. 3 Credit Hours.
First semester of a two semester sequence.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 752. Differential Geometry. 3 Credit Hours.
Second semester of a two semester sequence.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 757. Lie Groups. 3 Credit Hours.
Matrix Lie Groups, Lie Algebras, Lie Groups and Lie Algebra Homomorphisms, Basic Representation Theory, Baker-Campbell-Hausdorff Formula.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 761. Abstract Algebra I. 3 Credit Hours.
First semester of a two semester sequence: Group theory, ring theory, module theory, linear algebra.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 762. Abstract Algebra II. 3 Credit Hours.
Second semester of a two semester sequence: Group theory, ring theory, module theory, linear algebra.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 770. Directed Readings or Research. 2-4 Credit Hours.
Topics will vary at the discretion on faculty. Offering will be by arrangement.
Components: THI.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MTH 780. Topics in Analysis. 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 781. Topics in Analysis. 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 782. Topics in Topology. 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 783. Topics in Topology. 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 785. Topics in Algebra. 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 786. Topics in Mathematics. 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 787. Topics in Mathematics. 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 820. Research in Residence. 1 Credit Hour.
To establish a residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full-time residence.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MTH 830. Pre-Candidacy Doctoral Dissertation. 1-12 Credit Hours.
Credits earned in this course apply towards the 12 credit hour dissertation research requirement of the graduate school. The student will enroll for credit a s determined by his/her dissertation advisor. Up to 12 hours may be taken in a regular semester, but not more than six in a summer session.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

MTH 835. Research Project. 1-6 Credit Hours.
Directed Research Project as approved by faculty.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MTH 840. Post-Candidacy Doctoral Dissertation. 1-6 Credit Hours.
Credits earned in this course apply towards the 12 credit hour dissertation research requirement of the graduate school. The student will enroll for credit a s determined by his/her dissertation advisor. Up to 12 hours may be taken in a regular semester, but not more than six in a summer session.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

MTH 845. Research in Residence. 1 Credit Hour.
Research in Residence - establishing full-time status as a student.
Components: THI.
Grading: GRD.
Typically Offered: Fall & Spring.

MTH 850. Research in Residence. 1 Credit Hour.
Used to establish research in residence for the Ph.D. after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.