MATHEMATICS

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The Department of Mathematics offers two masters degrees, the Master of Science in Applied Mathematics (MAS), (p. 1) and the Master of Financial Mathematics (MFM) (p. 1). (p.)

Master of Science in Applied Mathematics (MAS)

The MAS program is interdisciplinary in nature. The program has a thirty three minimum credit hour requirement. There are two required courses, and a required three credit hour course in Mathematics Clinic that represents the research component for the master's program. There is a required area of concentration which consists of four courses. A student will then choose an additional four elective courses. Approved elective courses are listed below. Other elective courses can be approved with the agreement of the student's academic and research advisors.

It is expected that the research component, Mathematics Clinic, complement the student's area of concentration, thus, strengthening the plan of study. Areas of concentration can include courses outside the Department of Mathematics; such courses are approved to satisfy the area of concentration with the agreement of the student's academic and research advisors.

MTH 521	Real Analysis and Applications	3
MTH 541	Mathematics Clinic	3
MTH 565	Linear Algebra	3
Concentrations, choose one [1]		12
Dynamical Systems, choose four:		
MTH 531	Advanced Differential Equations	
MTH 532	Difference Equations & Applications	
MTH 535	Partial Differential Equations	
MTH 551	Methods of Mathematical Physics	
MTH 552	Methods of Applied Mathematics	
Applied Statistics:		
MTH 411 & MTH 412	Probability & Statistics I and Probability & Statistics II	
Choose two:		
MTH 543	Linear Models	
MTH 544	Time Series	
MTH 547	Statistics for Experimenters	
Computational Mathematics, choose four:		
MTH 535	Partial Differential Equations	
MTH 543	Linear Models	
MTH 555	Numerical Analysis I	
MTH 556	Numerical Analysis II	
MTH 563	Computational Finance	
Discrete Mathematics, choose four:		
MTH 531	Advanced Differential Equations	
MTH 543	Linear Models	
MTH 558	Financial Mathematics I-Discrete Model	
MTH 567	Combinatorial Design Theory	
MTH 568	Coding Theory	
Select four of the following electives: [2]		12
MTH 404	Complex Variables	
MTH 435	Advanced Multivariate Calculus	
MTH 531	Advanced Differential Equations	
MTH 532	Difference Equations & Applications	
MTH 535	Partial Differential Equations	
MTH 543	Linear Models	
MTH 544	Time Series	
MTH 547	Statistics for Experimenters	
MTH 555	Numerical Analysis I	
MTH 556	Numerical Analysis II	
MTH 558	Financial Mathematics I-Discrete Model [3]	
MTH 559	Financial Mathematics II-Continuous Model	
MTH 563	Computational Finance	
MTH 567	Combinatorial Design Theory	
MTH 568	Coding Theory	
Total Hours		33

1. Students, in consultation with the academic advisor, can construct other areas of concentration. These areas of concentration can be carefully constructed to include four-course concentrations in computer science, engineering or business for students with appropriate backgrounds.
2. At most 6 hours of approved 400-level courses may be part of a student's program.
3. MTH 558 serves as an approved elective for a master's candidate in only two cases: the candidate has selected the discrete mathematics concentration, or the candidate completes the sequence, MTH 558 – MTH 559.

Master of Financial Mathematics (FIM)

The Master of Financial Mathematics (MFM) is a certified Professional Science Master's program in quantitative methods in financial risk management with the purpose to support a growing local and regional market in financial services. It is offered in cooperation with the Department of Economics and Finance. The program integrates statistics, computation and modeling with training in the professional domain and graduates will find employment opportunities in the banking, insurance and financial trading industries. The program has a thirty-three minimum credit hour requirement. A plan of study includes an introductory required finance course, seven more required courses that include coursework in the MBA program, and two elective courses, selected, in consultation with a faculty advisor, from a set of electives from Computer Science, Mathematics and MBA. An eleventh three credit hour course, Mathematics Clinic, represents the master's level research for the program.

The introductory finance course can be waived for students with appropriate background in finance and replaced with an appropriate elective.

As with the MAS program, the MFM program requires the capstone research experience of a Mathematics Clinic project. Individual students or teams of students will report to a faculty member and work on a project that is posed by the financial industry.

Introductory course		3
MBA 620	Principles of Finance	
Required courses		21
MTH 544	Time Series	
MTH 556	Numerical Analysis II	
MTH 558	Financial Mathematics I-Discrete Model	
MTH 559	Financial Mathematics II-Continuous Model	
MTH 560	Advanced Topics in Financial Mathematics	
MTH 563	Computational Finance	
MBA 627	Financial Derivatives & Risk Management	
Research		3
MTH 541	Mathematics Clinic	
Choose two of the following electives:		6
CPS 542	Database Management Systems	
CPS 562	Database Management Systems II	
MBA 625	Investments	
MBA 628	Fixed Income Analysis	
MTH 521	Real Analysis and Applications	
MTH 535	Partial Differential Equations	
MTH 543	Linear Models	
MTH 547	Statistics for Experimenters	
Total Hours		33

Certificate Programs

Certificate programs appeal to students who do not want to commit to the full MFM program. Upon successful completion of five courses focused on a specific set of concepts, a student will earn a post-baccalaureate certificate in that area. The certificate programs and the associated five courses are:

Certificate in Computational Finance (CFN)

Certificate Requirements:

MTH 556	Numerical Analysis II	3
MTH 563	Computational Finance	3
MTH 558	Financial Mathematics I-Discrete Model	3
MTH 559	Financial Mathematics II-Continuous Model	3
MBA 627	Financial Derivatives & Risk Management	3
Total Hours		15

Certificate in Statistical Finance (STF)

Certificate Requirements:

MTH 543	Linear Models	3
or ENM 501	Applied Engineering Statistics	
MTH 544	Time Series	3
or ENM 530	Engineering Economy	
MTH 563	Computational Finance	3
MTH 558	Financial Mathematics I-Discrete Model	3
MTH 559	Financial Mathematics II-Continuous Model	3
Total Hours		15

Certificate in Financial Risk Management (FRM)

Certificate Requirements:

MBA 627	Financial Derivatives & Risk Management	3
MBA 628	Fixed Income Analysis	3
MTH 558	Financial Mathematics I-Discrete Model	3
MTH 559	Financial Mathematics II-Continuous Model	3
MTH 563	Computational Finance	3
Total Hours		15

The certificate programs are designed as mini-programs in focus areas. Thus, each includes the capstone applied research experience of Mathematics Clinic.

Entrance, performance, and exit standards

Students seeking admission to the Certificate Programs will satisfy the entrance requirements to the MFM program. These are:

- Completion of a graduate application for admission to a certificate program at the University of Dayton
- Bachelor's degree in a science or technical area such as mathematics, physics, computer science, engineering, economics or finance, and at least a 3.0 GPA on a 4.0 scale
- Prerequisite mathematics coursework in calculus, differential equations, linear algebra, elementary probability and statistics
- Programming skills

Students applying for a Certificate must be enrolled in the Certificate program and must have completed the requirement of five courses with a minimum G.P.A. of 3.0.

Students cannot simultaneously be admitted to the Master of Financial Mathematics and one of the certificate programs. Students can be simultaneously enrolled in any other post-baccalaureate program at the University of Dayton and a certificate program. Students must meet the entrance standards of the Master of Financial Mathematics to gain admission to a certificate program. To learn more about the application process for admission to a certificate program, please contact the Department of Mathematics.

Assistantships

Financial assistance is available to qualified students through graduate teaching assistantships. A graduate assistant receives a stipend, tuition remission and health benefits. Most graduate assistants require two years to complete the requirements for a master's degree. Internships in the MFM program are recommended and the Department facilitates finding internship opportunities.

Facilities

Departmental PCs and the MATHSCI Computer Learning Environment are available for student use in conjunction with projects or coursework.

Courses

MTH 512. Geometry for Secondary Teachers. 3 Hours
Investigation of traditional secondary school topics in Euclidean geometry, introduction to similar ideas in non-Euclidean spaces, examination of the impact of mathematics education research on the teaching and learning of geometry, and exploration of real-world applications. Extensive use of the dynamic software package The Geometer's Sketchpad® will also be incorporated into every aspect of the course. Topics to be explored may include transformations, symmetry, tessellations, centers of triangles (incenter, centroid, orthocenter, and circumcenter), similarity, coordinate geometry, and spherical or hyperbolic geometry. Prerequisite(s): MTH 370 or permission of instructor.

MTH 517. Trends & Issues in Mathematics Education. 3 Hours
Examine current issues and trends in mathematics education, relating to both research and practice, in learning, teaching, and curriculum. Readings from current literature in the field, from both a national and international perspective, will be explored, providing students with an understanding of the knowledge base in mathematics education. Prerequisite(s): (MTH 367 or MTH 412) or permission of instructor.

MTH 519. Statistical Inference. 3 Hours
Sample spaces, Borel fields, random variables, distribution theory, characteristic functions, exponential families, minimax and Bayes' procedures, sufficiency, efficiency, Rao-Blackwell theorem, Neyman-Pearson lemma, uniformly most powerful tests, multi-variate normal distributions.

MTH 520. Statistical Inference. 3 Hours
Sample spaces, Borel fields, random variables, distribution theory, characteristic functions, exponential families, minimax and Bayes' procedures, sufficiency, efficiency, Rao-Blackwell theorem, Neyman-Pearson lemma, uniformly most powerful tests, multi-variate normal distributions.

MTH 521. Real Analysis and Applications. 3 Hours
Introduction to topology of n-dimensional space, properties of sequences and series of functions, metric spaces and Banach spaces, contraction mapping principle, applications to fixed point theory, applications to successive approximations and implicit functions.

MTH 522. Real Variables. 3 Hours
The topology of the real line, continuity and differentiability, Riemann and Stieltjes integrals, Lebesgue measure and Lebesgue integral. Measure and integration over abstract spaces, Lp-spaces, signed measures, Jordan-Hahn decomposition, Radon-Nikodym theorem, Riesz representation theorem, and Fourier series.

MTH 525. Complex Variables I. 3 Hours
Analytic functions, integration on paths, the general Cauchy theorem. Singularities, residues, inverse functions and other applications of the Cauchy theory.

MTH 526. Complex Variables II. 3 Hours
Infinite products, entire functions, the Riemann mapping theorem and other topics as time permits. Prerequisite(s): MTH 525 or equivalent.

MTH 527. Biostatistics. 3 Hours
Introduction to statistical concepts and skills including probability theory and estimation, hypothesis tests of means and proportions for one or two samples using normal or t-distributions, regression and correlation, one- and two-way ANOVA, selected nonparametric tests.

MTH 531. Advanced Differential Equations. 3 Hours
Existence and uniqueness theorems, linear equations and systems, self-adjoin systems, boundary value problems and basic nonlinear techniques. Prerequisite(s): MTH 403 or equivalent.

MTH 532. Difference Equations & Applications. 3 Hours
The calculus of finite differences, first order equations, linear equations and systems, z-transform, stability, boundary value problems for nonlinear equations, Green's function, control theory and applications.

MTH 535. Partial Differential Equations. 3 Hours
Classification of partial differential equations; methods of solution for the wave equation, Laplace's equation, and the heat equation; applications. Prerequisite(s): MTH 403 or equivalent.

MTH 540. Mathematical Modeling. 3 Hours
An introduction to the use of mathematical techniques and results in constructing and modifying models designed to describe and/or predict behavior of real-world situations. Prerequisite(s): Permission of instructor.

MTH 541. Mathematics Clinic. 3 Hours
Student teams will be responsible for developing or modifying and testing a mathematical model designed for a particular purpose. Faculty guidance will be provided. May be repeated once for a maximum of 6 credit hours. Prerequisite(s): Permission of department chairperson or program director.

MTH 543. Linear Models. 3 Hours
Least square techniques, lack of fit and pure error, correlation, matrix methods, F test, weighted least squares, examination of residuals, multiple regression, transformations and dummy variables, model building, ridge regression, stepwise regression, multiple regression applied to analysis of variance problems. Prerequisite(s): MTH 368 or equivalent.

MTH 544. Time Series. 3 Hours
Estimation and elimination of trend and seasonal components; stationary time series, autocovariance, autocorrelation and partial autocorrelation functions; spectral analysis; modeling and forecasting with ARMA processes; nonstationary and seasonal time series. Prerequisite(s): Courses in single and multivariate calculus; courses in statistics and probability; courses in linear algebra.

MTH 545. Special Functions. 3 Hours
The special functions arising from solutions of boundary value problems which are encountered in engineering and the physical sciences. Hypergeometric functions, Bessel functions, Legendre polynomials. Prerequisite(s): MTH 403 or equivalent.

MTH 547. Statistics for Experimenters. 3 Hours
Covers those areas of design of experiments and analysis of quantitive data that are useful to anyone engaged in experimental work. Designed experiments using replication and blocking. Use of transformations. Applications of full and fractional factorial designs. Experimental design for developing quality into products using Taguchi methods. Prerequisite(s): MTH 367 or equivalent.

MTH 551. Methods of Mathematical Physics. 3 Hours
Linear transformations and matrix theory, linear integral equations, calculus of variations, eigenvalue problems. Prerequisite(s): MTH 403 or equivalent.

MTH 552. Methods of Applied Mathematics. 3 Hours
Dimensional analysis and scaling, regular and singular perturbation methods with boundary layer analysis, the stability and bifurcation of equilibrium solutions, other asymptotic methods. Prerequisite(s): MTH 403 or equivalent.

MTH 555. Numerical Analysis I. 3 Hours
Solutions of nonlinear equations, Newton's methods, fixed point methods, solutions of linear equations, LU decomposition, iterative improvement, QR decomposition, SV decomposition. Prerequisite(s): (CPS 132 or CPS 150) or equivalent; MTH 310 or equivalent.

MTH 556. Numerical Analysis II. 3 Hours
Interpolating functions, numerical differentiation, numerical integration including Gaussian quadrature, numerical solutions of differential equations. Prerequisite(s): (CPS 132 or CPS 150) or equivalent; MTH 219 or equivalent.

MTH 557. Financial Derivatives & Risk Management. 3 Hours
This course provides a theoretical foundation for the pricing of contingent claims and for designing risk-management strategies. It covers option pricing models, hedging techniques, and trading strategies. It also includes portfolio insurance, value-at-risk measure, multistep binomial trees to value American options, interest rate options, and other exotic options. Prerequisite(s): MBA 620.

MTH 558. Financial Mathematics I-Discrete Model. 3 Hours
Discrete methods in financial mathematics. Topics include introduction to financial derivatives, discrete probability theory, discrete stochastic processes (Markov chain, random walk, and Martingale), binomial tree models for derivative pricing and computational methods (European and American options), forward and futures, and interest rate derivatives. Prerequisite(s): MTH 411 or equivalent.

MTH 559. Financial Mathematics II-Continuous Model. 3 Hours
Continuous methods in financial mathematics. Topics include review of continuous probability theory, Ito's Lemma, the Black-Scholes partial differential equation, option pricing via partial differential equations, analysis of exotic options, local and stochastic volatility models, American options, fixed income and stopping time. Computational methods are introduced. Prerequisite(s): MTH 558.

MTH 560. Advanced Topics in Financial Mathematics. 3 Hours
Advanced topics in financial mathematics including: stochastic processes with jumps, Monte-Carlo simulations for financial models, portfolio selection problems. Quantitative theories and computational methods are introduced and employed, and are applied to some applications in financial mathematics. Prerequisite(s): MTH 559.

MTH 561. Modern Algebra I. 3 Hours
Groups, rings, integral domains and fields; extensions of rings and fields; polynomial rings and factorization theory in integral domains; modules and ideals.

MTH 562. Modern Algebra II. 3 Hours
Finite and infinite field extensions, algebraic closure, constructible numbers and solvability by use of radicals, Galois theory, and selected advanced topics. Prerequisite(s): MTH 561.

MTH 563. Computational Finance. 3 Hours
The purpose of this course is to introduce students to numerical methods and various financial problems that include portfolio optimization and derivatives valuation that can be tackled by numerical methods. Students will learn the basics of numerical analysis, optimization methods, monte carlo simulations and finite difference methods for solving PDEs. Prerequisite(s): MBA 620 or permission of instructor.

MTH 565. Linear Algebra. 3 Hours
Vector spaces, linear transformations and matrices; determinants, inner product spaces, invariant direct-sum decomposition and the Jordan canonical form.

MTH 567. Combinatorial Design Theory. 3 Hours
Latin squares, mutally orthogonal Latin squares, orthogonal and perpendicular arrays, Steiner triple systems, block designs, difference sets and finite geometries. Prerequisite(s): MTH 308 or instructor's permission.

MTH 568. Coding Theory. 3 Hours
The study of linear codes, Hamming and Golay codes, BCH codes, cyclic codes, random error detection and correction, burst-error correction, and decoding algorithms.

MTH 571. Topology. 3 Hours
An axiomatic treatment of the concept of a topological space; bases and subbases; connectedness, compactness; continuity, homeomorphisms, separation axioms and countability axioms; convergence in topological spaces.

MTH 572. Topology II. 3 Hours
Compactification theory, para-compactness and metrizability theorems, uniform spaces, function spaces, and other advanced topics of current interest. Prerequisite(s): MTH 571 or equivalent.

MTH 573. Functional Analysis. 3 Hours
The study of linear metric spaces with emphasis on Banach and Hilbert spaces. The Hahn-Banach theorem, the Banach fixed point theorem, and their consequences. Approximations and other selected advanced topics.

MTH 575. Differential Geometry. 3 Hours
Vector and tensor algebra; covariant differentiation. An introduction to the classical theory of curves and surfaces treated by means of vector and tensor analysis.

MTH 582. Vector & Tensor Analysis. 3 Hours
The differential and integral calculus of scalar and vector fields with emphasis on properties invariant under transformations to curvilinear coordinate systems. An introduction to tensor analysis via Cartesian tensors and then more general tensors. Derivation of the divergence, gradient, and curl in generalized coordinates. Prerequisite(s): (MTH 218, MTH 302) or equivalent.

MTH 583. Discrete & Continuous Fourier Analysis. 3 Hours
Fourier representations of complex-valued functions, rules for finding Fourier transforms, mathematical operators associated with Fourier analysis, fast algorithms, wavelet analysis, selected applications. Prerequisite(s): (MTH 219 or MTH 319) or equivalent; MTH 302 or equivalent.

MTH 590. Topics in Mathematics. 1-6 Hours
This course, given upon appropriate occasions, deals with specialized material not covered in the regular courses. May be taken more than once as topics change. Prerequisite(s): Permission of advisor.