MATHEMATICS

Wiebke Diestelkamp, Department Chairperson

The Department of Mathematics offers one master's degree, the Master of Science in Applied Mathematics (MAS) (p. 1).

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	Design of Experiments	
Computational Mathematics, choose four:		
MTH 535	Partial Differential Equations	
MTH 543	Linear Models	
MTH 555	Numerical Analysis	
MTH 556	Numerical Solution of Partial Differential Equations	
MTH 563	Computational Finance	
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	Design of Experiments	
MTH 555	Numerical Analysis	
MTH 556	Numerical Solution of Partial Differential Equations	
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.

Courses

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-adjoint systems, boundary value problems and basic nonlinear techniques. Basic knowledge of linear algebra and differential equations.

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. Prerequisites: Basic knowledge of linear algebra and differential equations.

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. Basic knowledge of linear algebra and differential equations.

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, stepwise regression, multiple regression applied to analysis of variance problems. Need knowledge of linear algebra. Prerequisite(s): MTH 367 or equivalent.

MTH 544. Time Series. 3 Hours
Multiple linear regression; time series regression, modeling of trends and seasonality, stationary time series, autocovariance, autocorrelation and partial autocorrelation functions, modeling and forecasting with ARMA processes, nonstationary and seasonal time series. Multivariable calculus and an introductory course in statistics.

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. Design of Experiments. 3 Hours
Single-factor analysis of variance: estimation of parameters, model adequacy checking; blocking in single-factor experiments; factorial designs; blocking and confounding; fractional factorial designs. 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. Basic knowledge of linear algebra and differential equations.

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. Basic knowledge of linear algebra and differential equations.

MTH 555. Numerical Analysis. 3 Hours
Floating point arithmetic, root finding for the nonlinear equation, fixed points analysis, solution of linear system, stability, use of Taylor's theorem to analyze the methods, numerical differentiation, numerical integration, computation of Eigenvalues and Eigenvectors (Power, Jacobi and QR methods), least squares (solved by SVD and QR algorithms), interpolation and numerical solution of ordinary differential equations using finite difference methods. Some programming experience; basic knowledge of Linear Algebra and Differential Equations.

MTH 556. Numerical Solution of Partial Differential Equations. 3 Hours
Short review of numerical linear algebra, solution of systems of nonlinear equations, stability of algorithms, iterative methods for linear systems, introduction to numerical solution of ordinary differential equations using Runge-Kutta methods, numerical solution of partial differential equations using finite difference methods and method of lines. Some programming experience; basic knowledge of Linear Algebra and Differential Equations.

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. Prerequisites: MBA 520 or 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. Prerequisites: MBA 520 or 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.