

# Mathematics (MATH)

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## Courses

### **MATH 5503 Survey of Combinatorics and Graph Theory: 3 semester hours.**

Enumeration techniques, including generating functions. Applications. Introductory graph theory. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 1175 AND MATH 2240, or permission of instructor.

### **MATH 5504 Topics in Combinatorics and Graph Theory: 3 semester hours.**

Continuation of MATH 5503. Application of algebraic, analytic, and/or probabilistic methods to combinatorial, graph-theoretic, and algorithmic problems. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 5503 or permission of instructor.

### **MATH 5505 Numerical Linear Algebra: 3 semester hours.**

Numerical techniques for problems in linear algebra, including solutions of linear systems, least squares, eigenvalue problems, and other topics with an emphasis on computation and applications. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 2240 and ME 1165 or CS 1181, or permission of the instructor.

### **MATH 5506 Advanced Linear Algebra: 3 semester hours.**

Advanced linear algebra with a strong emphasis on proof. Real and complex vector spaces, linear transformations, polynomials associated to matrices, determinants, canonical forms, inner product spaces. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 2240 or permission of instructor.

### **MATH 5507 Modern Algebra I: 3 semester hours.**

Rings, fields, groups, algebras, and selected topics in abstract algebra. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 2240 and MATH 2287, or permission of instructor.

### **MATH 5508 Modern Algebra II: 3 semester hours.**

Rings, fields, groups, algebras, and selected topics in abstract algebra. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 4407 or MATH 5507, or permission of instructor.

### **MATH 5521 Advanced Engineering Mathematics I: 3 semester hours.**

Analysis of complex linear and nonlinear engineering systems using advanced techniques, including Laplace transforms, Fourier series and classical partial differential equations. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 3360 or permission of instructor.

### **MATH 5522 Advanced Engineering Mathematics II: 3 semester hours.**

Analysis of complex linear and nonlinear engineering systems using advanced techniques, including probability and statistics, advanced numerical methods and variational calculus. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: ENGR 5521 or MATH 4421 or MATH 5521 or permission of instructor.

### **MATH 5523 Introduction to Real Analysis I: 3 semester hours.**

The real number system, topology of metric spaces, sequences, limits, series of functions and convergence, continuity, theory of differentiation and Riemann integration of functions of one variable and several variables, and selected topics on measure theory and integration. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: MATH 2240, MATH 2275, and MATH 3326 or permission of instructor.

### **MATH 5524 Introduction to Real Analysis II: 3 semester hours.**

The real number system, topology of metric spaces, sequences, limits, series of functions and convergence, continuity, theory of differentiation and Riemann integration of functions of one variable and several variables, and selected topics on measure theory and integration. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: MATH 4423 or MATH 5523 or permission of instructor.

### **MATH 5526 Elementary Analysis: 3 semester hours.**

A beginning course in analysis on the real line. Proof writing and the underlying logic are emphasized throughout the course. Topics include sets and functions, sequences, convergence, limits, continuity, and infinite series. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

### **MATH 5527 Vector Analysis: 3 semester hours.**

Calculus of vector functions of several variables, derivative matrix, chain rule, inverse function theorem, multiple integration. Change of variables. Integrals over curves and surfaces. Green's, Stokes and Divergence Theorems. Applications to Physics. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

### **MATH 5541 Introduction to Numerical Analysis I: 3 semester hours.**

Introduction to standard numerical techniques for solving problems dealing with nonlinear equations, systems of linear equations, differential equations, interpolation, numerical integration, and differentiation. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: MATH 2240, MATH 3326 and MATH 3360 or permission of instructor.

### **MATH 5542 Introduction to Numerical Analysis II: 3 semester hours.**

Extension of MATH 5541 for students who wish to pursue more advanced techniques with emphasis on analysis. Typical topics covered include numerical methods applied to partial differential equations, integral equations, and in-depth treatment of topics covered in MATH 5541. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: MATH 4441 or MATH 5541 or permission of instructor.

### **MATH 5543 Modern Geometry I: 3 semester hours.**

Planar Euclidean geometry. Rigid motions and symmetry in the plane. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

### **MATH 5544 Modern Geometry II: 3 semester hours.**

Transformation groups. Topics from hyperbolic, projective, and other geometries.

### **MATH 5550 Mathematical Statistics I: 3 semester hours.**

Probability, random variables, discrete and continuous distributions, order statistics, limit theorems, point and interval estimation, uniformly most powerful tests, likelihood ratio tests, chi-square and F tests, nonparametric tests. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: MATH 3326 and MATH 3352 or permission of instructor.

**MATH 5551 Mathematical Statistics II: 3 semester hours.**

Probability, random variables, discrete and continuous distributions, order statistics, limit theorems, point and interval estimation, uniformly most powerful tests, likelihood ratio tests, chi-square and F tests, nonparametric tests. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: MATH 4450 or MATH 5550 or permission of instructor.

**MATH 5552 Introduction to Probability: 3 semester hours.**

Fundamentals of probability, discrete and continuous random variables, distributions such as binomial, uniform, Poisson, hypergeometric, normal, gamma; expectation; joint, marginal, conditional distributions; central limit theorem; applications to statistics. Emphasizes material needed to develop statistical inference methods. Enrollment restricted to students admitted to MAMST program and approved by the departmental graduate committee.

**MATH 5553 Topics in Statistics: 1-3 semester hours.**

Content varies. May be repeated for up to 6 credits. SUGGESTED PREREQ: Permission of instructor.

**MATH 5555 Operations Research I: 3 semester hours.**

Deterministic problems in operations research oriented towards business. Includes linear programming, transportation problems, network analysis, PERT, dynamic programming, and elementary game theory. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

**MATH 5556 Operations Research II: 3 semester hours.**

Probabilistic models oriented towards business are treated. Selections from stochastic processes, Markov chains, queuing theory, inventory theory, reliability, decision analysis and simulation. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

**MATH 5557 Applied Regression Analysis: 3 semester hours.**

Simple and multiple linear regression, polynomial regression, diagnostics, model selection, models with categorical variables. SUGGESTED PREREQS: MATH 3350 or MATH 3352 or permission of instructor.

**MATH 5558 Experimental Design: 3 semester hours.**

The linear model for experimental designs, analysis of variance and covariance, block designs, factorial designs, nested designs, choice of sample size. SUGGESTED PREREQS: MATH 3350 or MATH 3352 or permission of instructor.

**MATH 5559 Applied Multivariate Analysis: 3 semester hours.**

Matrix computation of summary statistics, graphical analysis of multivariate procedures, multivariate normal distribution, MANOVA, multivariate linear regression, principal components, factor analysis, canonical correlation analysis. SUGGESTED PREREQS: MATH 2240 and one of the following: MATH 3350, MATH 5557, MATH 5558 or permission of instructor.

**MATH 5560 Differential Equations: 3 semester hours.**

Theory and applications of ordinary differential equations. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

**MATH 5562 Introduction to Complex Variables: 3 semester hours.**

Introduction to the study of functions of a complex variable including the algebra and geometry of complex numbers, analytic functions, power series, integral theorems, and applications. Enrollment restricted to students admitted to the MAMST program and approved by the departmental graduate committee.

**MATH 5563 Topics in Applied Mathematics: 3 semester hours.**

Topics that deal with mathematical methods that find use in other disciplines, business, and industry. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. Course may be repeated for a maximum of 6 credits. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQ: Permission of instructor.

**MATH 5565 Partial Differential Equations: 3 semester hours.**

Equations of the first and second orders, methods of solution, Laplace's Equation, heat equation, and the wave equation. Emphasis on applications to problems in the physical sciences and engineering. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. SUGGESTED PREREQS: MATH 2275 and MATH 3360, or permission of instructor.

**MATH 5581 Directed Reading and Problems: 1-3 semester hours.**

Reading and conference in an area not usually covered by a regular offering. Individual work under the supervision and guidance of a professor whose specialty includes the chosen area. Open to seniors and graduate students in good standing and with the consent of the instructor. May be repeated until 6 credits are earned.

**MATH 5591 Mathematics Seminar: 1-3 semester hours.**

Advanced reading and discussion on selected topics in mathematics. May be taken for credit more than once. SUGGESTED PREREQ: Senior standing or equivalent.

**MATH 5599 Experimental Course: 1-6 semester hours.**

The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

**MATH 6600 Introduction to College Mathematics Teaching: 1 semester hour.**

Practical course management issues for teaching mathematics at the college level. Open only to graduate students in mathematics. May not be repeated. Graded S/U.

**MATH 6610 Topics in College Mathematics Teaching: 1 semester hour.**

Theories and research related to mathematics teaching and learning. May be repeated. Graded S/U.

**MATH 6625 Real Analysis I: 3 semester hours.**

Measures, the Lebesgue integral,  $L_p$  spaces and other normed vector spaces, approximation theorems. SUGGESTED PREREQ: MATH 4424 or MATH 5524 or permission of instructor.

**MATH 6626 Real Analysis II: 3 semester hours.**

Measures, the Lebesgue integral,  $L_p$  spaces and other normed vector spaces, approximation theorems. SUGGESTED PREREQ: MATH 6625 or permission of instructor.

**MATH 6627 Complex Analysis I: 3 semester hours.**

Theory of functions of a single complex variable, including their differentiation, integration and representation by sums, products and integrals. The Cauchy integral formula and its consequences, conformal mappings, harmonic functions. SUGGESTED PREREQ: Permission of instructor.

**MATH 6628 Complex Analysis II: 3 semester hours.**

Theory of functions of a single complex variable, including their differentiation, integration and representation by sums, products and integrals. The Cauchy integral formula and its consequences, conformal mappings, harmonic functions. SUGGESTED PREREQ: MATH 6627 or permission of instructor.

**MATH 6631 Abstract Algebra I: 3 semester hours.**

Advanced theory and structural properties of groups, rings, modules, and fields, including topics such as group actions, universal maps, and Galois theory. SUGGESTED PREREQS: MATH 4408 or MATH 5508 or permission of instructor.

**MATH 6632 Abstract Algebra II: 3 semester hours.**

Advanced theory and structural properties of groups, rings, modules, and fields, including topics such as group actions, universal maps, and Galois theory. SUGGESTED PREREQS: MATH 6631 or permission of instructor.

**MATH 6633 Matrix Analysis: 3 semester hours.**

Eigenvalues, special matrices, normal forms, matrix polynomials, matrix functions, matrix norms, Kronecker products, stability, matrix equations, generalized inverses, nonnegative matrices. SUGGESTED PREREQS: MATH 4405 or MATH 5505 or MATH 4406 or MATH 5506 or permission of instructor.

**MATH 6636 Lie Groups and Lie Algebras I: 3 semester hours.**

Lie groups, Lie algebras, and their representations. Structure of real and complex Lie algebras. Representations of semi-simple Lie algebras and compact Lie groups. SUGGESTED PREREQS: MATH 4406 or MATH 5506 and MATH 4408 or MATH 5508, or permission of instructor.

**MATH 6637 Lie Groups and Lie Algebras II: 3 semester hours.**

Lie groups, Lie algebras, and their representations. Structure of real and complex Lie algebras. Representations of semi-simple Lie algebras and compact Lie groups. SUGGESTED PREREQS: MATH 6636 or permission of instructor.

**MATH 6641 Numerical Analysis I: 3 semester hours.**

Topics selected from approximation theory, optimization, numerical linear algebra, differential and integral equations, spline analysis, computer algorithms, and other areas of current research in numerical analysis. SUGGESTED PREREQS: MATH 4424 or MATH 5524 and MATH 4442 or MATH 5542, or permission of instructor.

**MATH 6642 Numerical Analysis II: 3 semester hours.**

Topics selected from approximation theory, optimization, numerical linear algebra, differential and integral equations, spline analysis, computer algorithms, and other areas of current research in numerical analysis. SUGGESTED PREREQS: MATH 6641 or permission of instructor.

**MATH 6650 Thesis: 1-6 semester hours.**

May be repeated. Graded S/U.

**MATH 6652 Stochastic Processes: 3 semester hours.**

Topics from conditional probability and expectation, martingales, Kolmogorovs Theorem, Markov processes, random walks, Brownian motion, diffusions, dynamic programming, stochastic differential equations. Applications to modeling physical and/or social dynamical systems. SUGGESTED PREREQ: MATH 4450 or MATH 5550 or permission of instructor.

**MATH 6653 Advanced Topics in Probability and Statistics: 3 semester hours.**

Topics such as experimental design, regression analysis, multivariate statistical analysis. SUGGESTED PREREQS: MATH 3352 and MATH 4406 or MATH 5506, or permission of instructor.

**MATH 6655 Combinatorics I: 3 semester hours.**

Theory and applications of: choice and enumeration techniques, generating functions, partitions, designs and configurations, graph theory including digraphs, algebraic graph theory and extremal problems. SUGGESTED PREREQ: Permission of instructor.

**MATH 6656 Combinatorics II: 3 semester hours.**

Theory and applications of: choice and enumeration techniques, generating functions, partitions, designs and configurations, graph theory including digraphs, algebraic graph theory and extremal problems. SUGGESTED PREREQ: MATH 6655 or permission of instructor.

**MATH 6662 Differential Equations I: 3 semester hours.**

Existence, uniqueness, and dependence of solutions upon initial conditions; linear equations; autonomous equations; dynamical systems and stability; partial differential equations of first and second order, with applications. SUGGESTED PREREQS: MATH 3326, MATH 3327, and MATH 3360, or permission of the instructor.

**MATH 6663 Differential Equations II: 3 semester hours.**

Existence, uniqueness, and dependence of solutions upon initial conditions; linear equations; autonomous equations; dynamical systems and stability; partial differential equations of first and second order, with applications. SUGGESTED PREREQS: MATH 6662 or permission of instructor.

**MATH 6664 Methods of Applied Mathematics I: 3 semester hours.**

Transform, spectral, variational and perturbation methods applied to the analysis of equations involving differential and integral operators. Emphasis on equations arising in physical and biological sciences. SUGGESTED PREREQS: MATH 4406 or MATH 5506 and MATH 4465 or MATH 5565, or permission of instructor.

**MATH 6665 Methods of Applied Mathematics II: 3 semester hours.**

Transform, spectral, variational and perturbation methods applied to the analysis of equations involving differential and integral operators. Emphasis on equations arising in physical and biological sciences. SUGGESTED PREREQS: MATH 6664 or permission of instructor.

**MATH 6667 Functional Analysis I: 3 semester hours.**

Major results of functional analysis, such as the Hahn-Banach, open mapping, and closed graph theorems; study of Hilbert and Banach spaces; spectral analysis. SUGGESTED PREREQS: MATH 4425 or MATH 5524 or permission of instructor.

**MATH 6668 Functional Analysis II: 3 semester hours.**

Major results of functional analysis, such as the Hahn-Banach, open mapping, and closed graph theorems; study of Hilbert and Banach spaces; spectral analysis. SUGGESTED PREREQS: MATH 6667 or permission of instructor.

**MATH 6671 Topology I: 3 semester hours.**

Fundamental theorems and examples from point-set topology; emphasis is on general and metric topologies and continuous mappings; introduction to topology of manifolds, covering spaces, homotopy, homology, and cohomology. SUGGESTED PREREQS: Permission of instructor.

**MATH 6672 Topology II: 3 semester hours.**

Fundamental theorems and examples from point-set topology; emphasis is on general and metric topologies and continuous mappings; introduction to topology of manifolds, covering spaces, homotopy, homology, and cohomology. SUGGESTED PREREQS: MATH 6671 or permission of instructor.

**MATH 6681 Differential Geometry I: 3 semester hours.**

Differentiable manifolds and mappings; bundles, connections, geodesics, and curvature; Lie groups; topics from Riemannian, Hermitian, or symplectic geometry. SUGGESTED PREREQ: MATH 3327 or permission of instructor.

**MATH 6682 Differential Geometry II: 3 semester hours.**

Differentiable manifolds and mappings; bundles, connections, geodesics, and curvature; Lie groups; topics from Riemannian, Hermitian, or symplectic geometry. SUGGESTED PREREQ: MATH 6681 or permission of instructor.

**MATH 6691 Directed Reading: 1-3 semester hours.**

Reading and problems arranged on an individual basis with a faculty supervisor.

**MATH 6692 Doctor of Arts Seminar: 2 semester hours.**

Topics include the nature and practice of mathematical research, grants, public speaking, professionally and classroom related software, information media, issues in mathematical pedagogy, standards, and curricula, university organization, history of mathematics. Graded S/U.

***MATH 6693 Mathematical Exposition: 1 semester hour.***

Presentation of mathematics in a seminar setting. Small group practice in and critique of mathematical exposition. Requirements include presentation of a departmental colloquium on an assigned topic. Graded S/U.

***MATH 6694 Special Topics in Mathematics: 1-3 semester hours.***

Each offering will deal with a topic selected from such fields of mathematics as algebra, analysis, geometry, number theory, topology, applied analysis, probability, and mathematical logic. May be taken for credit more than once.

***MATH 6699 Experimental Course: 1-6 semester hours.***

The content of this course is not described in the catalog. Title and number of credits are announced in the Class Schedule. Experimental courses may be offered no more than three times with the same title and content. May be repeated.

***MATH 7700 Supervised Teaching Internship: 1-9 semester hours.***

Graded S/U.

***MATH 7750 Thesis: 1-6 semester hours.***

Graded S/U.

***MATH 8850 Doctoral Dissertation: 1-9 semester hours.***

Variable credits. May be repeated. Graded S/U.