

MATHEMATICS COURSES ACCEPTABLE FOR GRADUATE CREDIT FOR THE MASTER OF SCIENCE WITH A MAJOR IN MATHEMATICS

The courses in this list can be counted toward the requirements of the Master of Science in Mathematics, with a concentration in Applied Mathematics. All courses are 3 credits unless otherwise indicated.

MATH 5234G NUMBER THEORY

Introduction to the principal ideas of elementary number theory: Divisibility, congruencies, linear Diophantine equations, Fermat's theorem, Euler's theorem, Pythagorean triple and the distribution of primes. Prerequisite: MATH 2332 (Mathematical Structures)

MATH 5330G OPERATIONS RESEARCH

Introduction to the basic deterministic and probabilistic operations research models of decision problems. Mathematical methods of optimization for these models will be analyzed both analytically and numerically. Prerequisite: MATH 3337 (Probability)

MATH 5331G ANALYSIS I

Provides a transition from calculus to real analysis. Emphasis will be placed on understanding and constructing mathematical proofs. Rigorous development of fundamental concepts in analysis, including topics such as relations, functions, limits of functions, cardinality, topology of the reals, completeness axioms, compact sets, sequences, subsequences, continuity and differentiability. Prerequisites: MATH 2243 (Calculus III) and MATH 2332 (Mathematical Structures)

MATH 5332G ANALYSIS II

A continuation of Analysis I, including topics such as Riemann integration, infinite series, sequences and series of functions, metric spaces and normed spaces. Prerequisite: MATH 5331 (Analysis I)

MATH 5333G MODERN ALGEBRA I

An introduction to the fundamental algebraic structures: groups, rings and fields. Topics covered include: binary operations, groups (permutation groups, subgroups, cyclic groups, group homomorphisms, factor groups), rings (integral domains, ring homomorphisms) and fields. The historical and mathematical connections to the secondary mathematics curriculum will be incorporated as appropriate. Prerequisite: MATH 2332 (Mathematical Structures)

MATH 5334G MODERN ALGEBRA II

A continuation of the study of the fundamental algebraic structures. Topics to be covered include: isomorphism of groups, rings, fields, a deeper study of quotient structures and the isomorphism theorems, field of quotients, factorization of polynomials over a field, arithmetic properties of rings of polynomials over fields, extension fields, algebraic extensions, geometric constructions and the classic problems. Prerequisite: MATH 5333 (Modern Algebra I)

MATH 5335G INTERMEDIATE LINEAR ALGEBRA

General vector spaces and bases, linear operators, least squares problems, eigenvalue problems, and applications of these concepts. Prerequisites: MATH 2331 (Elementary Linear Algebra) and MATH 2332 (Mathematical Structures)

MATH 5336G APPLIED NUMERICAL METHODS

Introduction to scientific computation on digital computers. Solution of nonlinear equations and systems of linear and nonlinear equations, polynomial interpolation, numerical differentiation and integration, data fitting and other numerical methods. Prerequisites: MATH 2331 (Elementary Linear Algebra) and knowledge of a programming language.

MATH 5337G DIFFERENCE EQUATIONS

An introduction to the theory and applications of difference equations. Topics include the difference calculus, first order linear difference equations, results and solutions of linear equations, applications, equations with variable coefficients and nonlinear equations that can be linearized. Prerequisites: MATH 2242 (Calculus II) and MATH 2331 (Elementary Linear Algebra)

MATH 5338G METHODS OF APPLIED MATHEMATICS

Methods of applied mathematics concentrating on techniques for the analysis of differential and integral equations. Topics include: Integral equations, differential operators, Fredholm alternative, distribution theory and Green's function methods. Prerequisites: MATH 2331 (Elementary Linear Algebra) and MATH 3230 (Differential Equations)

MATH 5339G PARTIAL DIFFERENTIAL EQUATIONS

The study of differential equations involving functions of more than one variable. Topics include: Laplace, heat and wave equations, boundary

value problems, methods of separation of variables and eigenfunction expansions, Fourier series, Green's functions, maximum principle and computational methods. Graduate students will be given an extra assignment not required of undergraduate students. Prerequisites: MATH 2243 (Calculus III) and MATH 3230 (Differential Equations)

MATH 5430G INTRODUCTION TO MATHEMATICAL BIOLOGY

An introduction to applications of mathematics to various biological, ecological, physiological, and medical problems, which will be analyzed both analytically and numerically. Prerequisite: MATH 3230 (Differential Equations) or permission of instructor.

MATH 5431G COMBINATORICS AND GRAPH THEORY

The course covers basic theory and applications of combinatorics and graph theory. Combinatorics is a study of different enumeration techniques of finite but large sets. Topics that will be studied include principle of inclusion and exclusion, generating functions and methods to solve difference equations. Graph theory is a study of graphs, trees and networks. Topics that will be discussed include Euler formula, Hamilton paths, planar graphs and coloring problem; the use of trees in sorting and prefix codes; useful algorithms on networks such as shortest path algorithm, minimal spanning tree algorithm and min-flow max-cut algorithm. Prerequisites: MATH 2332 (Mathematical Structures) and MATH 3337 (Probability)

MATH 5433G DIFFERENTIAL GEOMETRY OF CURVES AND SURFACES

Differential geometry uses tools from calculus and linear algebra to study the geometric properties of smooth curves and surfaces in Euclidean spaces. Topics include: arc length, surface area, geodesics, curvature, first and second fundamental forms, Gauss-Bonnet formula. Prerequisites: MATH 2243 (Calculus III) and MATH 2331 (Elementary Linear Algebra)

MATH 5434G FUNCTIONS OF A COMPLEX VARIABLE

Topics in complex variables including functions, limits, derivatives, integrals, the Cauchy-Riemann conditions, series representation of functions, Cauchy Integral formula and elementary conformal mappings. Prerequisite: MATH 2332 (Mathematical Structures).

MATH 5435G INTRODUCTION TO TOPOLOGY

An introduction to metric spaces, topological spaces, connectedness and compactness of topological spaces, and continuous functions on topological spaces. Prerequisite: MATH 2332 (Mathematical Structures).

MATH 5436G INTRODUCTION TO FRACTALS

Fractals as nonlinear systems involving feedback and iteration. Classical fractals, Limits and self-similarity. Fractal dimensions. Encoding of fractals. Decoding of fractals. Iterated function systems. Prerequisites: MATH 2243 (Calculus III), MATH 2332 (Mathematical Structures) and MATH 5335 (Intermediate Linear Algebra).

MATH 5437G MATHEMATICS OF COMPUTER-AIDED DESIGN

The study of the theory and techniques used for the computer generation of curves and surfaces. Topics include Bernstein/Bezier and B-spline curves and surfaces, transformations and projections, affine spaces and maps, geometric continuity, curvature, subdivision and interpolation. This course is recommended for students in mathematics, engineering and computer science. Prerequisite: MATH 2242 (Calculus II).

MATH 5539G MATHEMATICAL MODELS

This course introduces students to a variety of mathematical tools used for solving real world problems, with the focus on identifying the problem, constructing an appropriate model, and finding the best available method to solve it. Prerequisites: MATH 2331 (Elementary Linear Algebra) and MATH 3230 (Differential Equations)

MATH 7090 SELECTED TOPICS IN APPLIED MATHEMATICS

Specialized study in a selected area of Applied Mathematics. Prerequisites: Permission of Instructor.

MATH 7130 MATHEMATICAL OPTIMIZATION THEORY

Necessity and sufficiency conditions for constrained optimization problems are derived. The derived conditions are used to help answer questions concerning whether a given optimization problem has a solution, whether a solution is unique, and how a solution can be found. Prerequisite: MATH 5331 (Analysis I)

MATH 7132 METHODS OF OPTIMIZATION

Selected methods for unconstrained and constrained optimization problems with applications. Prerequisite: MATH 5330 (Operations Research) or permission of instructor.

MATH 7231 ADVANCED NUMERICAL ANALYSIS I

An in-depth study of computer arithmetic, the solution of non-linear equations, the solution of systems of linear equations, eigenvalue problems, and interpolation. Algorithms and methods are developed and then implemented on a computer. Prerequisite: MATH 5336 (Applied Numerical Methods).

MATH 7232 ADVANCED NUMERICAL ANALYSIS II

An in-depth study of orthogonal polynomials, numerical integration, and numerical solutions of ordinary and partial differential equations. Development and computer implementation of algorithms and methods. Prerequisite: MATH 7231 (ADVANCED NUMERICAL ANALYSIS I).

MATH 7234 ADVANCED LINEAR ALGEBRA

The study of linear maps on finite dimensional vector spaces. Topics include: diagonalization (direct sums, invariant subspaces and Cayley-Hamilton theorem for linear operators), inner product spaces (self-adjoint, orthogonal operators, orthogonal projections and the spectral theorem, bilinear and quadratic forms), canonical forms (Jordan and rational forms, minimal polynomials), special matrices (non-negative matrices), and the exponential of a linear operator. Prerequisite: MATH 5335 (Intermediate Linear Algebra)

MATH 7235 ANALYTIC NUMBER THEORY

A study of topics from the classical analytic theory of numbers. Topics will be chosen from arithmetic functions, the distribution of primes, congruences, the Riemann-zeta functions, the prime number theorem, Eisenstein series, quadratic residues, Dirichlet series, Euler products, the Dedekind eta function, the Jacobi theta functions, integer partitions, and modular forms. Prerequisites: MATH 5234 (Number Theory) and MATH 5434 (Functions of a Complex Variable)

MATH 7236 ADVANCED ORDINARY DIFFERENTIAL EQUATIONS

The theory of ordinary differential equations and dynamical systems. Topics include: Sturm-Liouville boundary value problems, eigenfunction expansions, Lyapunov stability, limit cycles, Poincare Bendixson theorem, Floquet's theory and Invariance theorems. Prerequisite: MATH 3230 (Differential Equations)

MATH 7237 MATHEMATICAL CONTROL THEORY

State-space techniques from modern control system theory. Topics include realization theory for MIMO systems, state-space techniques for feedback control, closed loop observer design, and state-space techniques in optimal control. Prerequisites: MATH 3230 (Differential Equations) and MATH 5336 (Applied Numerical Methods)

MATH 7330 FUNCTIONAL ANALYSIS

The study of normed linear spaces and linear operators. Topics include: Hilbert spaces (projection theorem, Riesz representation, Parseval relation); Banach spaces (convexity, duality, bounded and compact operators, theorems of Hahn-Banach, Banach-Steinhaus, open mapping, closed graph, Fredholm alternative); Stone-Weierstrass and Banach fixed point theorems. Prerequisites: MATH 5332 (Analysis II) and MATH 5335 (Intermediate Linear Algebra)

MATH 7331 REAL ANALYSIS

Theory of Lebesgue measure and integration, monotone convergence, the dominated convergence theorem, Fubini's Theorem, Radon-Nikodym theorem, Riesz representation theorem, L_p and l_p spaces, functions of finite variation, Stieltjes integral, absolute continuity. Prerequisite: MATH 5332 (Analysis II)

MATH 7332 ADVANCED PARTIAL DIFFERENTIAL EQUATIONS

The theory of linear and nonlinear partial differential equations. Topics include: Classical theory of elliptic, parabolic and hyperbolic partial differential equations and their solutions, potential theory, maximum principle, existence of weak solutions, regularity of solutions, Duhamel's principle and Cauchy's problem. Prerequisite: MATH 5339 (Partial Differential Equations)

MATH 7333 COMPLEX ANALYSIS

An in-depth study of functions of one complex variable. Topics include: properties of holomorphic, harmonic, meromorphic and entire functions (open mapping, maximum modulus, mean value, Poisson's, Rouché's, Liouville's, Picard's and Mittag-Leffler's theorems), residue theory (residue theorem, argument principle and applications), conformal mappings (Möbius and Christoffel-Schwarz canonical transformations, Riemann mapping theorem), analytic continuation (monodromy theorem, Schwarz reflection principle, Riemann surfaces and multi-valued functions). Prerequisites: MATH 5331 (Analysis I) and MATH 5434 (Functions of a Complex Variable)

MATH 7334 APPROXIMATION THEORY

The study of the approximation of functions in normed linear spaces. The course emphasizes the theory of interpolation and approximation by polynomials, rational functions and spline functions. Main topics include: best approximation, order of approximation, interpolation, existence and uniqueness of best approximants, theorems by Weierstrass, Haar, Chebyshev, Bernstein, Markov, Korovkin, Schoenberg, and applications. Prerequisites: MATH 5331 (Analysis I) and MATH 5335 (Intermediate Linear Algebra)

MATH 7430 ABSTRACT ALGEBRA I

This course provides a comprehensive study of group theory. The course begins with basic concepts of group theory (binary structures, subgroups, homomorphisms) and continues with the study of normal subgroups, quotient groups and the isomorphism theorems. Further topics to be studied include group actions, Sylow's theorem and the structure of finitely generated abelian groups. Prerequisites: MATH 5333 (Modern Algebra I)

MATH 7431 ABSTRACT ALGEBRA II

The course provides a comprehensive study of rings and fields. The course begins with the basic concepts (rings, subrings, ideals, quotient rings, homomorphisms), continues with the arithmetic of rings, applications to rings of polynomials and field theory, and concludes with a chapter on Galois theory that links field theory and group theory. Prerequisite: MATH 7430 (Abstract Algebra I)

MATH 7432 DIFFERENTIAL GEOMETRY OF MANIFOLDS

The study and applications of calculus on manifolds. Topics include: atlases, tangent spaces, differentiable maps; immersions and submanifolds, submersions and quotient manifolds; matrix groups and their Lie algebras; vector fields and flows; differential forms, exterior derivative, Lie derivative. Prerequisites: MATH 5331 (Analysis I) and MATH 5335 (Intermediate Linear Algebra)

MATH 7435 ELEMENTS OF ALGEBRAIC TOPOLOGY

The study of the topology of geometric objects from the algebraic viewpoint, in particular using homotopy and homology groups. Main topics: Topological manifolds, homotopy, fundamental group, free groups, covering spaces, homology. Prerequisites: MATH 5333 (Modern Algebra) and MATH 5435 (Introduction to Topology)

MATH 7610 GRADUATE SEMINAR

Under supervision of one or more faculty members, each student will choose topics related to his or her concentration, or topics of interest to the class, read and research on them, then make presentations in front of the class or a larger audience. Students will also attend presentations of internal and external speakers on mathematical sciences. Prerequisites: MATH 5332 (Analysis II), MATH 5335 (Intermediate Linear Algebra), MATH 7231 (Advanced Numerical Analysis I), and STAT 5531 (Statistical Methods I) (Any two of the above four courses)

MATH 7890 DIRECTED STUDY IN APPLIED MATHEMATICS

Directed study under faculty supervision. Prerequisite: Permission of Instructor and Department Chair.

MATH 7895 RESEARCH

Graduate students will conduct a program of independent research under the direction of a thesis advisor or an advisory committee on a topic in the Mathematical Sciences. Results of the research will be presented as a thesis in partial fulfillment of the requirement of the Master of Science degree.

MATH 7999 THESIS

Results of independent research conducted under the direction of a thesis advisor will be presented as a thesis in partial fulfillment of the Master of Science degree. The thesis will be defended before an advisory committee.