MATHEMATICS

Department of Mathematics

Chairperson: Dorina Mitrea
Graduate Program Director: Mark Sepanski

The Department of Mathematics has much to offer students. With excellent facilities housed in the centrally located Sid Richardson building, the department has a faculty and staff dedicated to helping our students. The Department of Mathematics offers the Master of Science and the Doctor of Philosophy degrees.

Admission

The minimum requirements for beginning graduate work in either the Master of Science or the Doctor of Philosophy degree is twenty-seven semester hours of approved mathematics. The GRE General Test is required of all applicants.

Application

The application procedure including the online application is described in the Admissions section under General Information of this catalog. The Department of Mathematics does not require any special material from the applicant.

Financial Support

The Department of Mathematics offers Graduate Teaching Assistantships to selected students. An assistantship provides a stipend at a competitive level and tuition remission for up to nine hours per semester. Support for one summer session is usually available. Graduate Assistants normally work as tutors, grade papers, or teach one course. An application to the graduate program in mathematics is also considered an application for an assistantship.

More information concerning the graduate programs in mathematics is available at www.baylor.edu/Math/ (http://www.baylor.edu/Math/).

- Mathematics, M.S. (https://catalog.baylor.edu/graduate-school/curriculum-departments-institutes-instruction/college-arts-sciences/mathematics/mathematics-ms/)
- Mathematics, Ph.D. (https://catalog.baylor.edu/graduate-school/curriculum-departments-institutes-instruction/college-arts-sciences/mathematics/mathematics-phd/)

Mathematics (MTH)

MTH 4314 Abstract Algebra (3)
Pre-requisite(s): A grade of C or above in MTH 2311 and MTH 3312; or consent of instructor
Fundamentals of group, ring, and field theory. Topics include permutation groups, group and ring homomorphisms, direct products of groups and rings, quotient objects, integral domains, field of quotients, polynomial rings, unique factorization domains, extension fields, and finite fields.

MTH 4322 Numerical Analysis (3)
Cross-listed as CSI 4322
Pre-requisite(s): A grade of C or above in MTH 2321
Numerical evaluation of derivatives and integrals, solution of algebraic and differential equations, and approximation theory.

MTH 4326 Advanced Calculus I (3)
Pre-requisite(s): A grade of C or above in MTH 2321 and MTH 3323 or consent of instructor
The real and complex number systems, basic topology, numerical sequences and series, continuity, differentiation, integration, sequences and series of functions.

MTH 4327 Advanced Calculus II (3)
Pre-requisite(s): A grade of C or above in MTH 4326
Line and surface integrals, Green, Gauss, Stokes theorems with applications, Fourier series and integrals, functions defined by integrals, introduction to complex functions.

MTH 4328 Numerical Linear Algebra (3)
Cross-listed as CSI 4328
Pre-requisite(s): A grade of C or above in MTH 2311
Numerical methods for solution of linear equations, eigenvalue problems, and least squares problems, including sparse matrix techniques with applications to partial equations.

MTH 4329 Theory of Functions of a Complex Variable (3)
Pre-requisite(s): A grade of C or above in MTH 2321
Number systems: the complex plane; fractions, powers, and roots; analytic functions; elementary functions; complex integration; power series; mapping by elementary functions; calculus of residues.

MTH 5100 Teaching Mathematics (1)
This course equips graduate students in mathematics with pedagogical strategies and techniques for teaching mathematics effectively in various settings. Topics covered include instructional design, assessment methods, communication skills, and addressing the needs of diverse learners.

MTH 5101 Teaching Mathematics Practicum (3)
This course gives new graduate student teachers a practicum experience in teaching mathematics. Mentoring on topics include instructional design, assessment methods, communication skills, and addressing the needs of diverse learners.

MTH 5310 Advanced Abstract Algebra I (3)
Pre-requisite(s): MTH 4314 and consent of the instructor
Finite groups, Sylow theorems, nilpotent and solvable groups, principal ideal domains, unique factorization domains, and sub rings to algebraic number fields.

MTH 5311 Advanced Abstract Algebra II (3)
Pre-requisite(s): MTH 5310
Field theory, Galois theory, modules, finitely generated modules, principal ideal domains, homological methods, and Wedderburn-Artin theorems.

MTH 5316 Linear Algebra and Matrix Theory (3)
Pre-requisite(s): MTH 3312
Matrix calculus, eigenvalues and eigenvectors, canonical forms, orthogonal and unitary transformations, and quadratic forms. Applications of these concepts. A course project is required and will be specified by the professor at the beginning of the course.

MTH 5323 Theory of Functions of Real Variables I (3)
Pre-requisite(s): MTH 4327
Borel sets, measure and measurable sets, measurable functions, and the Lebesque integral.

MTH 5324 Theory of Functions of Real Variables II (3)
Pre-requisite(s): MTH 5323
Function spaces, abstract measure, and differentiation.

MTH 5325 Theory of Differential Equations (3)
Pre-requisite(s): MTH 3325 and 5323
Initial value problems for ordinary differential equations: existence, uniqueness, continuous dependence, stability analysis, oscillation theory, general linear systems, phase plane analysis, limit cycles and periodic solutions. Topics of current interest in dynamical systems.

MTH 5326 Theory of Partial Differential Equations (3)
Pre-requisite(s): MTH 5324 and 5325
Linear and quasilinear first order equations; shocks, characteristics, the Cauchy problem, elliptic, hyperbolic, and parabolic equations, maximum principles, Dirichlet problem, operators, Sobolev spaces, distributions.

MTH 5330 Topology (3)
Pre-requisite(s): Graduate standing
Topological spaces, continuous functions, metric spaces, connectedness, compactness, separation axioms, Tychenoff theorem, fundamental group, covering spaces, metrization theorems.

MTH 5331 Algebraic Topology I (3)
Pre-requisite(s): MTH 5330
Homology theory, simplicial complexes, topological invariance, relative homology, Eilenberg-Steenrod axioms, singular homology, CW complexes.

MTH 5332 Algebraic Topology II (3)
Pre-requisite(s): MTH 5331
Cohomology theory, homology with coefficients, homological algebra, kunneth theorem, duality in manifolds.

MTH 5340 Differential Geometry (3)
Pre-requisite(s): MTH 4327, 5316, and 5330
Differentiable manifolds, submanifolds, vector fields, tensor fields, integration on manifolds, Riemannian geometry.

MTH 5344 Probability Theory (3)
Pre-requisite(s): MTH 5323
Topics include the law of large numbers, central limit theorems, random walks, martingales, Markov chains, ergodic Theorems, and Brownian motion.

MTH 5345 Functional Analysis (3)
Pre-requisite(s): MTH 5324
Banach spaces, Hilbert spaces, linear operators, and spectral theory.

MTH 5350 Complex Analysis (3)
Comoplex numbers, complex functions, analytic functions, linear fractional transformations, complex integration, Cauchy's formula, residues, harmonic functions, series and product expansions, gamma function, Riemann mapping theorem, Dirichlet problem, analytic continuation.

MTH 5351 Applications of Complex Analysis (3)
Pre-requisite(s): MTH 5350
Poisson summation, Mellin transformation, zeta function of Riemann, special functions, zeta functions associated with ezjen value problems, heat kernel, asymptotic expansion of the heat kernel, metamorphic structure of zeta functions, theta functions, elliptic functions.

MTH 5360 Applied Mathematics I (3)
Pre-requisite(s): Graduate standing
Dynamical systems (discrete and continuous), linear and nonlinear systems theory, transform methods, control theory and optimization, calculus of variations, stability theory.

MTH 5361 Applied Mathematics II (3)
Pre-requisite(s): Graduate standing
Eigenvalue theory, projections for linear equations, iteration and multilevel methods, fast Fourier Transforms, approximations of differential equations, grid adaptation and numerical stability, weak solutions and Sobolev space, wavelets.

MTH 5375 Linear Programming (3)
Pre-requisite(s): MTH 2311 and FORTRAN, or consent of instructor
Introduction to the theory and applications of linear programming, including the simplex algorithm, duality, sensitivity programming, including the simplex algorithm, duality, sensitivity analysis, parametric linear programming, integer programming, with applications to transportation and allocation problems and game theory. A course project is required and will be specified by the professor at the beginning of the course.

MTH 5376 Nonlinear Programming (3)
Theory and algorithms for the optimization of unconstrained problems including gradient and Quasi-Newton methods; and constrained problems to include feasible direction methods, Lagrange multipliers, and Kuhn-Tucker conditions. Students must have a knowledge of linear algebra, third-semester calculus, and FORTRAN.

MTH 5380 Statistical Methods for Research (3)
Pre-requisite(s): For graduate students from various disciplines
Introduction to the more common statistical concepts and methods. Emphasis is placed on proper applications of statistical tools. Topics include: interval estimation, tests of hypotheses, linear regression and correlation, categorical data analysis, design of experiments and analysis of variance, and the use of computer packages.

MTH 5390 Special Problems in Mathematics (3)
Project course for the project option in the M.S. degree.

MTH 5V91 Special Topics in Algebra for Graduates (1-3)
May be repeated for credit up to 18 hours.

MTH 5V92 Special Topics in Analysis for Graduates (1-3)
May be repeated for credit up to 18 hours.

MTH 5V93 Special Topics in Mathematics for Education Students (1-3)
Pre-requisite(s): Consent of departmental chair and the course instructor
May be repeated for credit for a maximum of nine semester hours if under different topics.

MTH 5V95 Special Topics in Topology-Geometry (1-3)
May be repeated for credit for a maximum of 9 semester hours.

MTH 5V96 Special Topics in Graph Theory (1-3)
Introduction to graph theory; Euler tours, matching, connectivity, planar graphs, coloring, and random graphs. Additional topics may vary by semester.

MTH 6310 Commutative Rings and Modules (3)
Pre-requisite(s): MTH 5311
Noetherian rings, quotient rings, primary decomposition, integral dependence and valuations, Dedekind domains, and discrete valuation rings, completions, dimension theory.

MTH 6311 Non-Commutative Rings and Modules (3)
Pre-requisite(s): MTH 6310
Semi-simple rings and modules, radicals, chain conditions, decomposition of modules, Goldie's theorem, density and Morita theory.

MTH 6312 Abelian Group Theory (3)
Pre-requisite(s): MTH 5311
An introduction to the fundamental theory of torsion, torsion-free, and mixed abelian groups.

MTH 6315 Homological Algebra (3)
Pre-requisite(s): MTH 5311 or consent of instructor
Categories, chain complexes, homology and cohomology, and derived functors. Detailed examination of Ext, Tor, adjoint functors, and direct and inverse limits for categories of modules. Kunneth formula and universal coefficient theorems. Cohomology of groups.

MTH 6322 Approximation Theory (3)
Pre-requisite(s): MTH 4322 and 4328
Approximation of real functions including polynomial and rational interpolation, orthogonal polynomials, Chebysher approximation, the fast Fourier transform, splines, wavelets, and tensor product interpolation.

MTH 6325 Numerical Solutions of Partial Differential Equations (3)
Pre-requisite(s): MTH 4322 and 4328
Finite difference and finite element methods for elliptic, parabolic, and hyperbolic problems in partial differential equations.

MTH 6340 Compact Lie Groups (3)
Pre-requisite(s): MTH 5310 and 5340
Compact Lie groups, Lie algebras, representation theory, orthogonality relations, Peter Weyl theorem, structure theory, roots, Weyl character formula.

MTH 6341 Lie Algebras (3)
Pre-requisite(s): MTH 5310 and 5316
Lie algebras, semisimple Lie algebras, root systems, conjugecy theorems, classification theorem, representation theory, Chevalley algebras.

MTH 6342 Semisimple Lie Groups (3)
Pre-requisite(s): MTH 6340 and 6341
Structure theory for noncompact groups, induced representations, tempered representations, Langland's classification of irreducible admissible representations.

MTH 6350 Set and Model Theory (3)
Pre-requisite(s): MTH 5311
Propositional and predicate calculus, Loewenheim-Skolem theorems, properties of ultraproducts, model completeness, Goedel's completeness/incompleteness proofs, infinitary language, axioms of set theory, ordinal and cardinals arithmetic, models of set theory and large cardinals.

MTH 6360 Harmonic Analysis and Singular Integrals (3)
Pre-requisite(s): MTH 5323
Topics which may vary by semester include: basic singular integral operators (Hilbert transform, Riesz transforms, Cauchy operator, boundary layer potentials), Calderon-Zygmund theory, boundedness results on Lp spaces, and applications to boundary value problems and partial differential equations.

MTH 6362 Fourier Analysis on Euclidean Spaces (3)
Introduction to Fourier Analysis; singular integrals, pseudodifferential operators, Lp estimates, and applications to partial differential equations. Additional topics may vary by semester.

MTH 6363 Analytic Number Theory (3)
Unique factorization, quadratic reciprocity, arithmetical functions, Dirichlet series, distribution of prime numbers. Additional topics may vary by semester.

MTH 6364 Algebraic Number Theory (3)
Class field theory, cyclotomic fields, p-adic L functions, and elliptic curves. Additional topics may vary by semester.

MTH 6365 Topics in Combinatorics (3)
Graphs, Ramsey theory, extremal set theory, generating functions, and partitions. Additional topics may vary by semester.

MTH 6366 Topic in Noncommutative Analysis (3)
Introduction to Positive definite matrices, Matrices of the trace class and the Schatten-p classes, Lp spaces associated with von Neumann algebras, Markov semigroup of operators, Noncommutative Hardy/BMO spaces, Free Fourier Multipliers, Shannon entropy, and Fisher information. Additional topics may vary by semester.

MTH 6367 Topics in Complex Analysis: Elliptic and Automorphic Functions (3)
Topics which may vary by semester include periodic meromorphic functions, elliptic Weierstrass functions, elliptic Jacobi functions, modular functions, Picard's theorems, modular group, automorphic functions, and applications to completely integrable systems

MTH 6368 Topics in Spectral Theory I (3)
Maximal and minimal operators, Weyl-Titchmarsh theory, spectral functions for second-order ODE operators, eigenfunction expansions. Topics may vary by semester.

MTH 6369 Topics in Operator Theory II: Compact Operators (3)
Compact operators, canonical decomposition of compact operators, singular values, l^p-based Schatten-von Neumann trace ideals, (regularized) Fredholm determinants, applications to the spectral theory of differential operators. Topics may vary by semester.

MTH 6V00 Graduate Research (1-10)
Pre-requisite(s): Graduate standing
For research credit prior to admission to candidacy for an advanced degree. Credit will be given for the amount of work done. May be repeated for credit through 45 hours.

MTH 6V13 Advanced Topics in Algebra (1-3)
Pre-requisite(s): Consent of instructor
May be repeated for credit up to 18 hours.

MTH 6V23 Advanced Topics in Analysis (1-3)
Pre-requisite(s): Consent of instructor
May be repeated for credit up to 18 hours.

MTH 6V24 Advanced Topics in Applied Mathematics (1-3)
Pre-requisite(s): Consent of instructor
May be repeated for credit up to 18 hours.

MTH 6V28 Advanced Topics in Numerical Analysis (1-3)
Pre-requisite(s): Consent of instructor
May be repeated for credit up to 18 hours.

MTH 6V30 Advanced Topics in Topology (1-3)
Pre-requisite(s): Consent of instructor
Topology is the study of abstract mathematical spaces with the ultimate goal of finding invariants that are preserved under continuous transformation. This course is intended for doctoral candidates with a strong interest in topology. May be repeated for credit.

MTH 6V43 Advanced Topics in Representation Theory (1-3)
Pre-requisite(s): Consent of instructor
May be repeated for credit up to 18 hours.

MTH 6V99 Dissertation (1-12)
Supervised research for the doctoral dissertation.