The courses offered by the Department of Mathematics serve several purposes: they supply the mathematical preparation necessary for students specializing in the physical, biological or social sciences, in business administration, in engineering, and in education; they provide a route by which students may arrive at the level of research competency in any of several special mathematical areas; they allow students to prepare themselves for work as mathematicians and statisticians in industry and government; and they give an opportunity to all inquisitive students to learn something about modern mathematical ideas.

BERMAN, ROBERT D.: Ph.D., University of Maryland; M.A., B.A., Wesleyan University; Professor

BRECKENRIDGE, JOHN C.: Ph.D., M.A., University of Michigan; B.A., Oberlin College; Associate Professor Emeritus

BRENTON, LAWRENCE: Ph.D., University of Washington; B.A., University of Pennsylvania; Professor Emeritus

BRUNER, ROBERT R.: Ph.D., M.S., University of Chicago; B.A., Amherst College; Professor

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CHOW, PAO-LIU: Ph.D., Rensselaer Polytechnic Institute; B.S., National Cheng Kung University; Professor

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HU, PO: Ph.D., University of Michigan; B.A., Yale University; Professor

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KAILI, HARDAMON: M.A.T., University of Phoenix; B.S. University of Michigan; Lecturer

KHASMINSKII, RAFAIL: Ph.D., DrSci, M.A., Moscow State University; Distinguished Professor Emeritus

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LEBIEZIK, CATHERINE: Ph.D., M.A., University of Virginia; B.S., Pennsylvania State University; Associate Professor

LEE, KYUNGYONG: Ph.D., University of Michigan; B.A., Seoul National University; Assistant Professor

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LI, HENGGUANG: Ph.D., Pennsylvania State University; B.S., Peking University; Associate Professor and Chair

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MEI, TAO: Ph.D., Texas A&M University; Assistant Professor

MORDUKHOVICH, BORIS S.: Ph.D., M.S., Byelorussian State University; Distinguished Professor

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SCHOCHET, CLAUDE L.: Ph.D., M.S., University of Chicago; B.A., University of Minnesota; Professor Emeritus

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SUN, TZE-CHIEN: Ph.D., Brown University; B.S., National Taiwan University; Professor

UMIRBAEV, UALBAI: Ph.D., D.Sc. Sobolev Institute of Mathematics; M.S., Novosibirsk State University; Professor
VINCENTINI, ANDREW: M.Ed., B.S., Wayne State University; Lecturer

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YIN, GANG: Ph.D., M.S., Brown University; B.S., University of Delaware; Professor

ZHANG, SHENG: Ph.D., Pennsylvania State University; Ph.D., Chinese Academy of Sciences; M.S., Xian Jiaotong University; B.S., Northwestern University of China; Associate Professor

ZHANG, ZHIMIN: Ph.D., University of Maryland at College Park; M.S., B.S., University of Science and Technology; Professor

• Mathematics (M.S.) (http://bulletins.wayne.edu/graduate/college-liberal-arts-sciences/mathematics/mathematics-ms)
• Mathematics (M.A.) (http://bulletins.wayne.edu/graduate/college-liberal-arts-sciences/mathematics/mathematics-ma)
• Mathematical Statistics (M.A.) (http://bulletins.wayne.edu/graduate/college-liberal-arts-sciences/mathematics/mathematical-statistics-ma)
• Applied Mathematics (M.A.) (http://bulletins.wayne.edu/graduate/college-liberal-arts-sciences/mathematics/applied-mathematics-ma)
• Mathematics (Ph.D.) (http://bulletins.wayne.edu/graduate/college-liberal-arts-sciences/mathematics/mathematics-phd)

Mathematics

MAT 5000 Fundamental Concepts of Mathematics and Proof Writing Cr. 3
Fundamental concepts: basic logic, basic set theory, functions, equivalence relations. Proof: methods of proof, structures of proofs, proof-writing in a variety of mathematical subjects. Not considered a 5000+ level course for undergraduate degree requirements in mathematics; no credit toward graduate degree in mathematics. Offered Fall, Winter.

Prerequisites: MAT 2250 with a minimum grade of C- or MAT 2860 with a minimum grade of C-

MAT 5030 Statistical Computing and Data Analysis Cr. 3
Computational aspect of statistics and data analysis for advanced undergraduate and beginning graduate students. Topics include descriptive statistics, probability distributions, hypothesis testing, ANOVA, linear regression and logistic regression. Data analysis by use of statistical packages such as R, SAS, Python, SPSS or Minitab. Satisfies Society of Actuaries Validation by Educational Experience (VEE) in Applied Statistics for regression component with a B- or better. Offered Every Year.

Prerequisites: MAT 2250 with a minimum grade of C- or MAT 2150 with a minimum grade of C- and MAT 2210 with a minimum grade of C- or MAT 5700 with a minimum grade of C- or BE 2100 with a minimum grade of C- or ECO 5100 with a minimum grade of C- or PH 3200 with a minimum grade of C-

MAT 5070 Elementary Analysis Cr. 4
Topics include: the real numbers, cardinality, sequences, limits, continuity, uniform continuity, differentiation, integration. Offered Every Term.

Prerequisites: 1 of MAT 2250, MAT 2350, MAT 2150 and MAT 2030 with a minimum grade of C- or MAT 2150 with a minimum grade of C- or MAT 2250 with a minimum grade of C- or MAT 2350 with a minimum grade of C-

MAT 5100 Numerical Methods I Cr. 3
Numerical errors; solutions of nonlinear equations; polynomial interpolation; numerical approximation; numerical integration and differentiation; numerical solutions of systems of linear equations; numerical solutions of ordinary differential equations. Offered Yearly.

Prerequisites: 1 of CSC 1100, BE 1500 and MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C- or BE 1500 with a minimum grade of C- or CSC 1100 with a minimum grade of C- and CSC 1101 with a minimum grade of C-

MAT 5110 Numerical Methods II Cr. 3

Prerequisites: MAT 5100 with a minimum grade of C- and MAT 2150 with a minimum grade of C- or MAT 2350 with a minimum grade of C-

MAT 5120 Abstract Algebra for Middle School Teachers Cr. 3
Topics from elementary abstract algebra underpinning middle school mathematics curriculum; historical connections; role of abstraction and proof in mathematics. No credit towards major in mathematics or secondary mathematics. Offered for undergraduate credit only. Offered Fall, Winter.

Prerequisites: MAT 1120 with a minimum grade of C- and MAT 1800 with a minimum grade of C-

Restriction(s): Enrollment is limited to Undergraduate level students.
Equivalent: MAE 5120

MAT 5130 Problem Solving for Middle School Teachers Cr. 3
Development of mathematical problem solving in middle grades mathematics education; study of non-routine problems; problem solving strategies; historical connections; connections to selected mathematics content and to topics in other disciplines. No credit towards a mathematics major or secondary mathematics education major. Offered for undergraduate credit only. Offered Spring/Summer.

Prerequisites: MAT 1120 with a minimum grade of C- and MAT 1800 with a minimum grade of C-

Restriction(s): Enrollment is limited to Undergraduate level students.
Equivalent: MAE 5130

MAT 5180 Geometry for Middle School Teachers Cr. 3
Development of Euclidean geometry as a mathematical system; related historical topics; introduction to other geometries; selected topics such as transformations and tessellations. No credit toward a major or minor for secondary mathematics teaching. Offered for undergraduate credit only. Offered Fall, Winter.

Prerequisites: MAT 1110 with a minimum grade of C- and MAT 1120 with a minimum grade of C-

Restriction(s): Enrollment is limited to Undergraduate level students.
Equivalent: MAE 5180

MAT 5190 Number Theory for Middle School Teachers Cr. 3
Topics from elementary theory of numbers which underlie middle school mathematics; historical connections; role of abstraction and proof in mathematics. No credit toward a major or minor for secondary mathematics teaching. Offered for undergraduate credit only. Offered Fall, Winter.

Prerequisites: MAT 1800 with a minimum grade of C- or MAT 1120 with a minimum grade of C-

Restriction(s): Enrollment is limited to Undergraduate level students.
Equivalent: MAE 5190
MAT 5210 Advanced Calculus Cr. 4
Functions of many variables; limits, continuity; differentiation, mean value theorems; implicit and inverse function theorems; extremal problems, Lagrange multipliers; fixed-point methods; Taylor series; Fourier series, uniform convergence; improper integrals. Offered Yearly.
Prerequisites: MAT 2250 with a minimum grade of C-

MAT 5220 Partial Differential Equations Cr. 4
Partial differential equations of mathematical physics; method of separation of variables; Fourier series; Sturm-Liouville eigenvalue problems; boundary-value problems; method of eigenfunction expansion. Optional topics include: Green's functions; solutions by Fourier transform; method of characteristics. Offered Biannually.
Prerequisites: MAT 5070 with a minimum grade of C-

MAT 5230 Complex Variables and Applications Cr. 4
Cauchy-Riemann equations; elementary functions; mappings by elementary functions; the Cauchy integral formula; Morera's theorem; Taylor series; Laurent series; residues and poles; conformal mappings. Optional topics: improper integrals, the Schwarz-Christoffel transformations; potential theory; applications to differential and integral equations. No credit after MAT 6600. Offered Biannually.
Prerequisites: MAT 5070 with a minimum grade of C-

MAT 5280 Methods of Differential Equations Cr. 3
Linear nth order differential equations; linear systems of differential equations (constant and periodic coefficients); oscillation and comparison theorems for second order differential equations; boundary value problems; stability theory (Lyapunov's direct method and frequency domain stability criteria); asymptotic solutions; autonomous non-linear systems; classification of singularities. Offered Biannually.
Prerequisites: MAT 2150 with a minimum grade of C- or MAT 2350 with a minimum grade of C-

MAT 5350 Logical Systems I Cr. 4
&copy; 2023 The Math Forum. All rights reserved. The Math Forum is a research and educational organization. Mathematics is a discipline with a rich history and diverse applications. This course provides an in-depth exploration of logical systems, including propositional logic, predicate logic, and modal logic. It covers topics such as logical connectives, truth tables, logical equivalence, and logical proofs. The course also delves into the semantics of logical languages and the relationship between syntax and semantics.

MAT 5400 Elementary Theory of Numbers Cr. 3
Primes and the Fundamental Theorem of Arithmetic; greatest common divisor, least common multiple, Euclidean Algorithm; congruences, theorems of Fermat, Wilson and Euler; arithmetic functions; linear Diophantine equations; quadratic congruences and the Law of Quadratic Reciprocity. Optional topics include: applications to cryptography, perfect numbers, primitive roots and indices, Fibonacci numbers, Pythagorean triples, sums of squares, continued fractions. Offered Yearly.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5410 Applied Linear Algebra Cr. 4
Gaussian elimination, vector spaces, the four fundamental subspaces, orthogonality, least squares approximation, determinants, eigenvalues and eigenvectors, positive definite matrices, singular value decomposition, linear transformations, complex matrices. Applications such as differential and difference equations, Markov processes, graphs and networks, Fourier series, computer graphics, numerical linear algebra. Offered Biannually.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5420 Algebra I Cr. 4
Abstract concepts: sets, mappings, equivalence relations, induction, general methods of proof. Group theory: groups, subgroups, cyclic groups, direct products, cosets, Lagrange's Theorem, quotient groups, homomorphisms, permutation groups. Rings and fields (basic definitions). Only two credits apply after either MAT 6170 or 6180; no credit after both MAT 6170 and 6180. Offered Every Term.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5430 Algebra II Cr. 4
Group theory continued: Sylow Theorems, finite abelian groups. Ring theory: rings, integral domains, fields of quotients, homomorphisms, ideals, quotient rings, PID's, UFD's, polynomial rings. Advanced topics in linear algebra: canonical forms. Field theory: extensions, splitting fields, finite fields, geometric constructions. Offered Every Term.
Prerequisites: MAT 5420 with a minimum grade of C-

MAT 5520 Introduction to Topology Cr. 3
An introduction to topology, mostly through an intuitive approach. Topics chosen from among: topological equivalence and topological properties, complexes, Euler characteristic, connectedness, compactness, continuity, Brouwer's Fixed Point Theorem, vector fields, Hairy Ball Theorem, n-dimensional spaces, classification of surfaces, cut and paste techniques, the Moebius band, orientability, the fundamental group. No credit toward graduate degree in mathematics or statistics. Offered Yearly.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 5000 with a minimum grade of C-

MAT 5530 Elementary Differential Geometry and its Applications Cr. 3
Introduction to the differential geometry of curves and surfaces in three-dimensional space. Curvature, torsion, Frenet formulas, fundamental theorem of space curves. Gauss and mean curvature, asymptotic and principal curves, geodesics, Gauss-Bonnet theorem. Applications such as pursuit curves, roulettes, brachistochrones, precession of Foucault's pendulum, design of packaging machines, shapes and soap films. Offered Irregularly.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5600 Introduction to Analysis I Cr. 4
Completeness, convergence, compactness, connectedness and continuity in the context of metric spaces; applications to differential calculus. Offered Every Term.
Prerequisites: MAT 5070 with a minimum grade of C-

MAT 5610 Introduction to Analysis II Cr. 3
Integration, point-wise and uniform convergence of sequences and series of functions; power series; introduction to analytic functions; Fourier series; possible additional topics. Offered Every Term.
Prerequisites: MAT 5600 with a minimum grade of C-

MAT 5700 Introduction to Probability Theory Cr. 4
Probability spaces; combinatorial analysis; independence and conditional probability; discrete and continuous random variables including binomial, Poisson, exponential and normal distributions; expectations; joint, marginal and conditional distribution functions; law of large numbers; central limit theorems. Offered Every Term.
Prerequisites: 1 of MAT 2150, MAT 2250, MAT 2350 and MAT 2030 with a minimum grade of C- and MAT 2150 with a minimum grade of C- or MAT 2250 with a minimum grade of C- or MAT 2350 with a minimum grade of C-

MAT 5710 Introduction to Stochastic Processes Cr. 3
Non-measure-theoretic introduction to the theory of stochastic processes and its applications, with emphasis on Markov processes in both discrete and continuous time, the Poisson process, and Brownian motion. Offered Biannually.
Prerequisites: MAT 5700 with a minimum grade of C-
MAT 5740 The Theory of Interest Cr. 3
Concrete problems used to explore concepts in the theory of interest, including measurement of interest, annuities, yield rates, amortization, bonds, and stochastic approaches. Students prepare for the actuarial examination FM/2. Offered Yearly.
Prerequisites: MAT 2020 with a minimum grade of C-

MAT 5750 Mathematics of Finance Cr. 3
Topics to be covered include: financial markets, binomial models, stocks and options, Black-Scholes formula, hedging, bond models and interest rate options, and computational methods for bonds. Offered Winter.

MAT 5770 Mathematical Models in Operations Research Cr. 3
Deterministic and probabilistic mathematical modeling of real-world problems. Linear and nonlinear programming; Markov chains; queuing theory; inventory models; Markov decision processes. Offered Biannually.
Prerequisites: MAT 2030 with a minimum grade of C-, MAT 2250 with a minimum grade of C-, and MAT 5700 with a minimum grade of C-

MAT 5830 Applied Time Series Cr. 3
Time series models, moving average models, autoregressive models, non-stationary models, and more general models; point estimators, confidence intervals, and forecast in the time domain. Statistical analysis in the frequency domain; spectral density and periodogram. Satisfies Society of Actuaries Validation by Educational Experience (VEE) in Applied Statistics for regression component with a B- or better Offered Biannually.
Prerequisites: MAT 2250 with a minimum grade of C- or MAT 2150 with a minimum grade of C- and MAT 2210 with a minimum grade of C- or BE 2100 with a minimum grade of C- or ECO 5100 with a minimum grade of C- or PH 3200 with a minimum grade of C-

MAT 5870 Methods of Optimization Cr. 3
Introduction to basic mathematical theory and computational methods of optimization; unconstrained and constrained optimization problems; optimality conditions in various optimization problems; numerical methods of optimization. Offered Yearly.
Prerequisites: MAT 2150 with a minimum grade of C- or MAT 2250 with a minimum grade of C-

MAT 5890 Special Topics in Mathematics Cr. 3-4
Material currently of interest to students and faculty. Topics to be announced in Schedule of Classes. Offered Irregularly.
Prerequisites: 1 of MAT 2250, MAT 2350, MAT 2150 and MAT 2030 with a minimum grade of C- and MAT 2210 with a minimum grade of C- or BE 2100 with a minimum grade of C- or ECO 5100 with a minimum grade of C- or PH 3200 with a minimum grade of C-

MAT 5990 Directed Study Cr. 1-4
Undergraduates who elect this course must be mathematics majors of honors caliber. Content will vary to satisfy needs of individual student. Offered Every Term.
Repeatability for 12 Credits

MAT 5992 Teaching Mathematics in College Cr. 1
Preparation for first semester of teaching in developmental-level mathematics course. Content presentation, test-writing, grading, classroom management, use of technology. Students are videotaped and critiqued. Required of all graduate teaching assistants in Mathematics Department. Offered for S and U grades only. Offered Fall.
Restriction(s): Enrollment is limited to Graduate or Undergraduate level students; enrollment limited to students with a class of Senior; enrollment is limited to students with a major in Mathematics or Mathematics Honors.

MAT 5993 Writing Intensive Course in Mathematics Cr. 0
Satisfies General Education Requirement: Writing Intensive Course in Mathematics Honors caliber. Content will vary to satisfy needs of individual student. Undergraduates who elect this course must be mathematics majors of honors caliber. Offered Yearly.

MAT 6140 Geometry: An Axiomatic Approach Cr. 3
Prerequisites: MAT 2010 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Education.

MAT 6150 Probability and Statistics for Teachers Cr. 4
Counting techniques, discrete sample spaces and probability, random variables, mean and variance, joint distributions, the binomial and normal distributions, central limit theorem, estimation and hypothesis testing. Not available to Math majors for degree credit. Offered Every Term.
Prerequisites: MAT 1800 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Education.

MAT 6170 Algebra: Ring Theory Through Exploration, Conjecture, and Proof Cr. 4
Rings: basic definitions; properties; examples including the integers, rationals, reals, and complex numbers; ideals; homomorphisms; and divisibility. Connections to high school algebra. Students will be involved in the mathematical processes of exploration, conjecture, and proof. Only two credits after MAT 5420; no credit after MAT 5430. Offered Irregularly.
Prerequisites: MAT 5000 with a minimum grade of C-

MAT 6180 Algebra: Group Theory Through Exploration, Conjecture, and Proof Cr. 3
Groups: basic definitions, properties, examples, subgroups, cyclic groups, permutation groups, homomorphisms, quotient groups. Connections to high school algebra. Students will be involved in the mathematical processes of exploration, conjecture, and proof. Offered Yearly.
Prerequisites: MAT 5000 with a minimum grade of C-

MAT 6200 Teaching Arithmetic, Algebra and Functions from an Advanced Perspective Cr. 3
Students gain profound understanding of K-12 mathematics. Concepts underlying K-12 topics and procedures; connections to higher mathematics. Teaching with Simplicity; applying mathematical understanding to teaching practices. Offered Yearly.
Prerequisites: MAT 5120 with a minimum grade of C- or MAT 6170 with a minimum grade of C-
Equivalent: MAE 6200
MAT 6210 Teaching Geometry, Probability and Statistics, and Discrete Mathematics from an Advanced Perspective Cr. 3
Historical perspectives, common conceptions and misconceptions, applications, technology, and mathematical connections relative to teaching geometry (including trigonometry), probability and statistics, and discrete mathematics in secondary school. Offered Yearly.
Equivalent: MAE 6210

MAT 6420 Advanced Linear Algebra Cr. 3
Prerequisites: MAT 5430 with a minimum grade of C-

MAT 6500 Topology I Cr. 3
Topological spaces and continuous functions; connectedness; compactness; product and quotient spaces; metric spaces; Urysohn's lemma; Tietze extension theorem; homotopy; covering spaces and path lifting; the fundamental group and examples; Brouwer fixed point theorem and applications. Offered Yearly.
Prerequisites: MAT 5610 with a minimum grade of C-

MAT 6600 Complex Analysis Cr. 2-4
Complex differentiation; elementary functions; Cauchy's integral theorem; power series; Laurent expansions; singularities; residue theorem; entire and meromorphic functions; Riemann mapping theorem. Offered for three credits only, if student has taken MAT 5230. Offered Yearly.
Prerequisites: MAT 5610 with a minimum grade of C-

MAT 6840 Linear Statistical Models Cr. 3
Multivariate linear regression models, examples; least square estimates and system of normal equations; the Gauss-Markov theorem; hypothesis testing about regression coefficients; confidence intervals and regions; prediction; model selection, stepwise regression. Analysis of variances (ANOVA). Offered Biannually.
Prerequisites: MAT 5800 with a minimum grade of C-

MAT 6990 Internship in Mathematical Sciences Cr. 1-3
Experience in industry, or in a research laboratory, or in an institution, using tools from the mathematics curriculum. Students provide a written report based on the internship experience. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students in the Department of Mathematics.
Repeatable for 3 Credits

MAT 7200 Ordinary Differential Equations Cr. 3
Existence and uniqueness of solutions; linear solutions and linearization; linear differential equations in the complex domain; solutions near regular and irregular singular points; autonomous systems; stability theory; limit cycles; perturbation theory; boundary value problems; Green's function; spectral theory. Offered Biannually.
Prerequisites: MAT 5610 with a minimum grade of C or MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7210 Partial Differential Equations Cr. 3
Linear partial differential equations; fundamental solutions; distributions and their Fourier transforms; hyperbolic equations; Cauchy-Kovalevsky theorem; energy inequalities; weak solutions; propagation of singularities; elliptic equations; maximum principles; Sobolev spaces and inequalities; Garding's inequality; existence and regularity of solutions of Dirichlet problems; fundamental solutions of parabolic equations; strongly continuous semigroups. Offered Biannually.
Prerequisites: MAT 5610 with a minimum grade of C or MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7220 Advanced Numerical Analysis Cr. 3
Modern iterative methods for solving systems of linear and nonlinear equations, such as: conjugate gradient method, generalized minimum residue (GMRES) method, inexact Newton's Method; Newton-GMRES, multigrid and domain decomposition methods. Offered Biannually.
Prerequisite: MAT 5100 with a minimum grade of C and MAT 5110 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7230 Finite Element Methods Cr. 3
Topics chosen at discretion of instructor from topics similar to: regularity theory for second order elliptic partial differential equations; Hamilton-Jacobi equations; conservation laws; evolution equations; semigroup theory; calculation of variations; nonvariational methods. Offered Biannually.
Prerequisite: MAT 5100 with a minimum grade of C and MAT 5070 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7240 Advanced Partial Differential Equations Cr. 3
Continuation of MAT 7210. Variety of topics chosen by the instructor. Offered Biannually.
Prerequisite: MAT 7210 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7270 Topics in Applied Mathematics Cr. 3-4
Topics of special interest such as differential equations; calculus of variations; elliptic functions; orthogonal functions; numerical methods; systems and control theory. Topics to be announced in Schedule of Classes. Offered Biannually.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7400 Advanced Algebra I Cr. 4
Permutation groups; Sylow Theorems; Jordan-Holder theorem; solvable and nilpotent groups; free groups; unique factorization domains; principal ideal domains; modules over principal ideal domains; linear transformations; Cayley-Hamilton theorem; free modules; noetherian rings; localization. Offered Biannually.
Prerequisite: MAT 5430 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7410 Advanced Algebra II Cr. 3
Field extensions; finite fields; Galois theory; classical applications of Galois theory; algebraic closure; tensor and exterior algebras; determinants; alternating, quadratic and hermitian forms. Offered Biannually.
Prerequisite: MAT 7400 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7470 Topics in Algebra Cr. 3-4
Selected topics from linear algebra; homological algebra; group theory; field theory. Topics to be announced in Schedule of Classes. Offered Irregularly.
Prerequisite: MAT 7410 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7500 Topology II Cr. 3
Smooth manifolds and maps; examples from projective spaces, from Lie groups, and from low dimensions; local coordinates; partitions of unity; tangent vectors and tangent bundles; differentials of smooth maps; vector fields; local one-parameter groups of diffeomorphisms; differential forms; integration and Stokes theorem; definition of deRham cohomology. Offered Biannually.
Prerequisite: MAT 6500 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
MAT 7510 Algebraic Topology I Cr. 3
Homology and its applications including fixed-point theorems; Jordan-Brouwer separation theorem; invariance of domain; CW-complexes; Kunneth theorem. Offered Biannually.
Prerequisite: MAT 5430 with a minimum grade of C and MAT 6500 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7520 Algebraic Topology II Cr. 3
Cohomology ring; orientation and duality on manifolds; homotopy theory, Hurewicz theorem. Offered Biannually.
Prerequisite: MAT 7510 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7570 Topics in Geometry and Topology Cr. 3-4
Selected topics from geometry and topology; Lie groups, Riemannian and differential geometry. Offered Fall, Winter.
Prerequisite: MAT 7510 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7600 Real Analysis I Cr. 3
Lebesgue measure; general measures; measurable functions; integration (monotone and dominated convergence theorems); function spaces; Lebesgue spaces; modes of convergence; product measures; Fubini theorem. Offered Biannually.
Prerequisite: MAT 5610 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7610 Real Analysis II Cr. 3
Differentiation; relationship between differentiation and integration; Radon-Nikodym theorem; Fourier transforms; Hilbert and Banach spaces; selected topics. Offered Biannually.
Prerequisite: MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7630 Introduction to Real Harmonic Analysis Cr. 3
Singular integrals, fractional integrals, interpolation theorems, Sobolev functions, BMO functions, Hardy space theory, Poincare and Sobolev inequalities, LP and Schauder estimates for elliptic PDEs analysis on the Heisenberg groups and Lie groups. Offered Biannually.
Prerequisite: MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7670 Topics in Analysis Cr. 3
Topics include: advanced harmonic analysis theory, applications to PDEs, geometric analysis, Fourier analysis, advanced theory of complex variables, analysis on manifolds, advanced PDEs. Offered Yearly.
Prerequisite: MAT 7610 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7700 Advanced Probability Theory I Cr. 3
Probability spaces; random variables; expectations and moments; convergence concepts; product spaces and Kolmogorov extension theorem; separability of random processes; continuity of random processes; conditional expectation; independence. Offered Biannually.
Prerequisite: MAT 5700 with a minimum grade of C and MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7710 Advanced Probability Theory II Cr. 3
Law of large numbers; characteristic functions; limit theorems; random walks; Markov processes; stationary processes; ergodic theory; martingales; stopping times. Offered Biannually.
Prerequisite: MAT 7700 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7770 Special Topics in Probability Cr. 3-4
Topics of special interest such as Markov processes; time series; ergodic theory; random equations; probability measures on algebraic structures; probability measures in Banach spaces; martingales; Brownian motion; stochastic integrals. Topics to be announced in Schedule of Classes. Offered Irregularly.
Prerequisite: MAT 7710 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7990 Directed Study Cr. 1-4
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7999 Master's Essay Direction Cr. 1-3
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students with a class of Candidate Masters.
Repeatable for 3 Credits

MAT 8000 Advanced Topics in Mathematics Cr. 2-4
Topics to be announced in Schedule of Classes. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 24 Credits

MAT 8999 Master's Thesis Research and Direction Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students with a class of Candidate Masters.
Repeatable for 8 Credits

MAT 9000 Advanced Topics in Mathematics Cr. 3-4
Topics to be announced in Schedule of Classes.

MAT 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

MAT 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

MAT 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

MAT 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.

MAT 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Prerequisite: MAT 9994 with a minimum grade of S
Repeatable for 0 Credits
Statistics

STA 5030 Statistical Computing and Data Analysis Cr. 3
Computational aspect of statistics and data analysis for advanced undergraduate and beginning graduate students. Topics include descriptive statistics, probability distributions, hypothesis testing, ANOVA, linear regression and logistic regression. Data analysis by use of statistical packages such as R, SAS, Python, SPSS or Minitab. Satisfies Society of Actuaries Validation by Educational Experience (VEE) in Applied Statistics for regression component with a B- or better. Offered Yearly.

Prerequisites: MAT 2250 with a minimum grade of C- or MAT 2150 with a minimum grade of C- and MAT 2210 with a minimum grade of C- or MAT 5700 with a minimum grade of C- or BE 2100 with a minimum grade of C- or ECO 5100 with a minimum grade of C- or PH 3200 with a minimum grade of C-
Equivalent: MAT 5030

STA 5800 Introduction to Mathematical Statistics Cr. 4
A one-semester course for senior undergraduate and master's degree students. Introduction to basic mathematical theory of statistics. Topics include survey sampling, estimation theory, data analysis and sample statistics, testing hypothesis, two sample cases, analysis of variance, regression analysis, Bayesian inference. Satisfies Society of Actuaries Validation by Educational Experience (VEE) in Applied Statistics for regression component with a B- or better. Offered Yearly.

Prerequisite: MAT 5700 with a minimum grade of C-

STA 5830 Applied Time Series Cr. 3
Time series models, moving average models, autoregressive models, non-stationary models, and more general models; point estimators, confidence intervals, and forecast in the time domain. Statistical analysis in the frequency domain; spectral density and periodogram. Satisfies Society of Actuaries Validation by Educational Experience (VEE) in Applied Statistics for regression component with a B- or better. Offered Biannually.

Prerequisites: MAT 2250 with a minimum grade of C- or MAT 2150 with a minimum grade of C- and MAT 2210 with a minimum grade of C- or BE 2100 with a minimum grade of C- or ECO 5100 with a minimum grade of C- or PH 3200 with a minimum grade of C-
Equivalent: MAT 5830

STA 6830 Design of Experiments Cr. 3
Randomized blocks; Latin and Graeco-Latin squares; factorial designs; confounding; split plot; fractional replication; balanced incomplete blocks. Offered Irregularly.

Prerequisites: MAT 2250 with a minimum grade of C- or MAT 2150 with a minimum grade of C- and MAT 2210 with a minimum grade of C- or BE 2100 with a minimum grade of C- or ECO 5100 with a minimum grade of C- or PH 3200 with a minimum grade of C-

STA 6840 Linear Statistical Models Cr. 3
Multivariate linear regression models, examples; least square estimates and system of normal equations; the Gauss-Markov theorem; hypothesis testing about regression coefficients; confidence intervals and regions; prediction; model selection, stepwise regression. Analysis of variances (ANOVA). Offered Biannually.

Prerequisites: MAT 5800 with a minimum grade of C-
Equivalent: MAT 6840

STA 7810 Advanced Statistics Theory I Cr. 3
First of two basic courses for Ph.D. students in the Mathematics Department who are interested in statistics. Topics include sample distribution theory, point and interval estimations, optimal estimates, theory of hypothesis testing, and most powerful tests. Offered Biannually.

Prerequisite: MAT 5610 with a minimum grade of C and MAT 5700 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

STA 7820 Advanced Statistics Theory II Cr. 3
Continuation of STA 7810. Topics include regression analysis, linear models, analysis of categorical data, nonparametric statistics, decision theory, and Bayesian inference. Offered Biannually.

Prerequisite: MAT 7810 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

STA 7870 Topics in Statistics Cr. 3-4
Selected topics such as statistical estimation theory; theory of statistical hypothesis testing; non-parametric methods in statistics; statistical sequential analysis; statistical multivariate analysis. Topics to be announced in Schedule of Classes. Offered Biannually.

Prerequisite: MAT 7810 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits