MATHEMATICS (MATH)

Courses

MATH 1005 (3) Introduction to College Mathematics
Introductory level mathematics course which presents a college level introduction to algebraic functions and their applications. Only offered through the Student Academic Service Center.
Equivalent - Duplicate Degree Credit Not Granted: MATH 1011
Additional Information: MAPS Course: Mathematics

MATH 1011 (3) College Algebra
Covers simplifying algebraic expressions, factoring, linear and quadratic equations, inequalities, exponentials, logarithms, functions, graphs and systems of equations. Department enforced prerequisite: one year high school algebra.
Equivalent - Duplicate Degree Credit Not Granted: MATH 1005
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math
MAPS Course: Mathematics

MATH 1012 (3) Quantitative Reasoning and Mathematical Skills
Promotes mathematical literacy among liberal arts students. Teaches basic mathematics, logic, and problem-solving skills in the context of higher level mathematics, science, technology, and/or society. This is not a traditional math class, but is designed to stimulate interest in and appreciation of mathematics and quantitative reasoning as valuable tools for comprehending the world in which we live.
Equivalent - Duplicate Degree Credit Not Granted: MATH 1112
Additional Information: GT Pathways: GT-MA1 - Mathematics
Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math
MAPS Course: Mathematics

MATH 1021 (3) College Trigonometry
Covers trigonometric functions, identities, solutions of triangles, addition and multiple angle formulas, inverse and trigonometric functions and laws of sines and cosines. Department enforced prerequisite: MATH 1011 (minimum grade C-) or 1 1/2 years of high school algebra and 1 year of high school geometry.
Equivalent - Duplicate Degree Credit Not Granted: APPM 1235 or MATH 1150

MATH 1071 (3) Finite Mathematics for Social Science and Business
Discusses systems of linear equations and introduces matrices, linear programming, and probability.
Requisites: Requires prerequisite course of MATH 1011 (minimum grade C-) or a score of 46% or greater on an ALEKS math exam taken in 2016 or earlier.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1081 (3) Calculus for Social Science and Business
Covers differential and integral calculus of algebraic, logarithmic and exponential functions. For more information about the math placement referred to in the "Enrollment Requirements", contact your academic advisor.
Equivalent - Duplicate Degree Credit Not Granted: APPM 1345 or APPM 1350 or ECON 1088 or MATH 1300 or MATH 1310 or MATH 1330
Requisites: Requires prerequisite course of ECON 1078 or MATH 1011 or MATH 1071 or MATH 1150 or MATH 1160 (minimum grade C-) or an ALEKS math exam taken in 2016 or earlier, or placement into pre-calculus based on your admission data and/or CU Boulder coursework.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1110 (3) Mathematics for Elementary Educators 1
Includes a study of problem solving techniques in mathematics and the structure of number systems. Department enforced prereq., one year of high school algebra and one year of geometry. Department enforced restriction: restricted to prospective elementary teachers.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1112 (4) Mathematical Analysis in Business
Gives students experience with mathematical problem solving in real business contexts. Students will work with data and spreadsheets to build and analyze mathematical models. Themes of the course include applying logical operators to model business rules, interpreting data and using tables and graphs, finding break-even and optimal points, and addressing uncertainty and forecasting
Equivalent - Duplicate Degree Credit Not Granted: MATH 1012
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math
MAPS Course: Mathematics

MATH 1120 (3) Mathematics for Elementary Educators 2
Topics include geometry, measurement, probability, and statistics. Department enforced restriction: restricted to prospective elementary teachers.
Requisites: Requires prerequisite course of MATH 1110 (minimum grade C-).
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1130 (3) Mathematics from the Visual Arts
Introduces mathematical concepts through the study of visual arts.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1150 (4) Precalculus Mathematics
Develops techniques and concepts prerequisite to calculus through the study of trigonometric, exponential, logarithmic, polynomial and other functions. For more information about the math placement referred to in the "Enrollment Requirements", please contact your academic advisor.
Equivalent - Duplicate Degree Credit Not Granted: APPM 1235 or MATH 1021
Requisites: Requires prerequisite course of MATH 1011 (minimum grade C-) or an ALEKS math exam taken in 2016 or earlier, or placement into pre-calculus based on your admissions data and/or CU Boulder coursework. Requires enrollment in corequisite course MATH 1151.
Additional Information: GT Pathways: GT-MA1 - Mathematics
Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math
MAPS Course: Mathematics

MATH 1151 (1) Precalculus Supplemental Lab
Provides students concurrently enrolled in MATH 1150 with supplemental instruction.
Requisites: Requires enrollment in corequisite course of MATH 1150.
Grading Basis: Letter Grade

MATH 1160 (3) Transition to Calculus (IBL): The Theory, Applications and Analysis of Functions
Examines the functions of calculus and how they can be used to model concrete problems and/or change. This is an intensive study of these functions through Inquiry-Based Learning. Each class will be designed so students will be actively engaged in learning the material in small groups. For more information about the math placement referred to in the "Enrollment Requirements", please contact your academic advisor.
Requisites: Requires an ALEKS math exam taken in 2016 or earlier, or placement into pre-calculus based on your admissions data and/or CU Boulder coursework.

MATH 1212 (3) Data and Models
Engages students in statistical and algebraic problem solving through modeling data and real world questions taken from the social and life sciences. The course will emphasize these skills and the mathematical background needed for a university level statistics course.
Equivalent - Duplicate Degree Credit Not Granted: MATH 1011
Grading Basis: Letter Grade
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math
MAPS Course: Mathematics

MATH 1300 (5) Calculus 1
Topics include limits, derivatives of algebraic and transcendental functions, applications of the derivative, integration and applications of the definite integral. Students who have already earned college credit for calculus 1 are eligible to enroll in this course if they want to solidify their knowledge base in calculus 1. For more information about the math placement referred to in the "Enrollment Requirements", contact your academic advisor.
Equivalent - Duplicate Degree Credit Not Granted: APPM 1345 or APPM 1350 or ECON 1088 MATH 1081 or MATH 1310 or MATH 1330
Requisites: Requires prerequisite course of MATH 1011 and MATH 1021 or MATH 1150 or MATH 1160 or APPM 1235 (minimum grade C-) or an ALEKS math exam taken in 2016 or earlier, or placement into calculus based on your admissions data and/or CU Boulder coursework.
Additional Information: GT Pathways: GT-MA1 - Mathematics
Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1301 (1) Calculus 1 Supplemental Lab
Provides students concurrently enrolled in MATH 1300 with supplemental instruction.
Requisites: Requires corequisite course of MATH 1300.
Grading Basis: Letter Grade

MATH 1310 (5) Calculus for Life Sciences
Calculus concepts are developed through the analysis and modeling of complex systems, ranging from gene networks and cells to populations and ecosystems. Fundamental concepts of probability and statistics are also developed through the lens of calculus. MATH 1300 is similar, but a greater emphasis is placed on relevance and applications in biology and other life sciences. Students who have already earned college credit for calculus 1 are eligible to enroll in this course if they want to solidify their knowledge base in calculus 1. For more information about the math placement referred to in the "Enrollment Requirements", contact your academic advisor.
Equivalent - Duplicate Degree Credit Not Granted: APPM 1345 or APPM 1350 or ECON 1088 or MATH 1081 or MATH 1300 or MATH 1330
Requisites: Requires prerequisite course of APPM 1235 or MATH 1021 or MATH 1150 or MATH 1160 or MATH 1300 (minimum grade C-) or an ALEKS math exam taken in 2016 or earlier, or placement into calculus based on your admissions data and/r CU Boulder coursework.
Additional Information: GT Pathways: GT-MA1 - Mathematics
Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 1330 (4) Calculus for Economics and the Social Sciences
A calculus course intended to meet the needs of social science and economics majors, including applications. Covers differential and integral calculus of algebraic, logarithmic and exponential functions and modeling. For more information about the math placement referred to in the "Enrollment Requirements", contact your academic advisor.
Equivalent - Duplicate Degree Credit Not Granted: APPM 1345 or APPM 1350 or ECON 1088 or MATH 1081 or MATH 1300 or MATH 1310
Requisites: Requires a prerequisite course of ECON 1078 or MATH 1011 or MATH 1071 or MATH 1150 or MATH 1160 (minimum grade C-) or an ALEKS math exam taken in 2016 or earlier, or placement into calculus based on your admissions data and/r CU Boulder coursework.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 2001 (3) Introduction to Discrete Mathematics
Introduces the ideas of rigor and proof through an examination of basic set theory, existential and universal quantifiers, elementary counting, discrete probability, and additional topics.
Equivalent - Duplicate Degree Credit Not Granted: MATH 2002
Requisites: Requires prerequisite course of MATH 1300 or MATH 1310 or APPM 1345 or APPM 1350 (all minimum grade C-).

MATH 2002 (3) Number Systems: An Introduction to Higher Mathematics
Introduces the concepts of mathematical proofs using the construction of the real numbers from set theory. Topics include basic logic and set theory, equivalence relations and functions, Peano's axioms, construction of the integers, the rational numbers and axiomatic treatment of the real numbers.
Equivalent - Duplicate Degree Credit Not Granted: MATH 2001
Requisites: Requires prerequisite of MATH 1300 or MATH 1310 or APPM 1345 or APPM 1350 (all minimum grade C-).

MATH 2130 (3) Introduction to Linear Algebra for Non-Mathematics Majors
Examines basic properties of systems of linear equations, vector spaces, inner products, linear independence, dimension, linear transformations, matrices, determinants, eigenvalues, eigenvectors and diagonalization. Intended for students who do not plan to major in Mathematics. Formerly MATH 3130.
Equivalent - Duplicate Degree Credit Not Granted: MATH 2135 or APPM 3310
Requisites: Requires prerequisite course of MATH 2300 or APPM 1360 (minimum grade C-).

MATH 2135 (3) Introduction to Linear Algebra for Mathematics Majors
Examines basic properties of systems of linear equations, vector spaces, inner products, linear independence, dimension, linear transformations, matrices, determinants, eigenvalues, eigenvectors and diagonalization. Intended for students who plan to major in Mathematics. Formerly MATH 3135.
Equivalent - Duplicate Degree Credit Not Granted: MATH 2130 or APPM 3310
Requisites: Requires a prerequisite course of (MATH 2300 or APPM 1360) and (MATH 2001 or MATH 2002) (all minimum grade C-).

MATH 2300 (5) Calculus 2
Continuation of MATH 1300. Topics include transcendental functions, methods of integration, polar coordinates, differential equations, improper integrals, infinite sequences and series, Taylor polynomials and Taylor series. Department enforced prerequisite: MATH 1300 or MATH 1310 or APPM 1345 or APPM 1350 (minimum grade C-).
Equivalent - Duplicate Degree Credit Not Granted: APPM 1360
Requisites: Requires prerequisite course of MATH 1300 or MATH 1310 or APPM 1345 or APPM 1350 (minimum grade C-).

MATH 2380 (3) Mathematics for the Environment
An interdisciplinary course where environmental issues, such as climate change, global epidemics, pollution, population models and kinship relations of Australian Aborigines are studied with elementary mathematics (such as fuzzy logic). Similar techniques are applied to analyze other current events, such as surveillance, economic meltdowns, identity theft and media literacy. Department enforced prerequisite: proficiency in high school mathematics.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math

MATH 2400 (5) Calculus 3
Continuation of MATH 2300. Topics include vectors, three-dimensional analytic geometry, partial differentiation and multiple integrals, and vector analysis. Department enforced prerequisite: MATH 2300 or APPM 1360 (minimum grade C-).
Equivalent - Duplicate Degree Credit Not Granted: APPM 2350
Requisites: Requires prerequisite course of MATH 2300 or APPM 1360 (minimum grade C-).

MATH 2510 (3) Introduction to Statistics
Elementary statistical measures. Introduces statistical distributions, statistical inference, hypothesis testing and linear regression. Department enforced prerequisite: two years of high school algebra.
Additional Information: Arts Sci Core Curr: Quant Reasn Mathmat Skills
Arts Sci Gen Ed: Quantitative Reasoning Math
MAPS Course: Mathematics

MATH 3001 (3) Analysis 1
Provides a rigorous treatment of the basic results from elementary Calculus. Topics include the topology of the real line, sequences of numbers, continuous functions, differentiable functions and the Riemann integral.
Requisites: Requires prerequisite courses of (MATH 2001 or MATH 2002) and (MATH 2130 or MATH 3130 or MATH 2135 or MATH 3135) (all minimum grade C-).

MATH 3110 (3) Introduction to Theory of Numbers
Studies the set of integers, focusing on divisibility, congruences, arithmetic functions, sums of squares, quadratic residues and reciprocity, and elementary results on distributions of primes.
Requisites: Requires prerequisite of MATH 2001 or MATH 2002 (both minimum grade C-).

MATH 3120 (3) Functions and Modeling
Engages the students in daily projects and occasional in-class labs designed to strengthen and expand knowledge of the topics in secondary mathematics, focusing especially on topics from algebra, precalculus and calculus. Projects and labs involve the use of multiple representations, transformations, data analysis techniques and interconnections among ideas from geometry, algebra, probability and calculus.
Requisites: Requires prerequisite of MATH 2001 or MATH 2002 (both minimum grade C-).

MATH 3130 (3) Introduction to Linear Algebra
Examines basic properties of systems of linear equations, vector spaces, inner products, linear independence, dimension, linear transformations, matrices, determinants, eigenvalues, eigenvectors and diagonalization.
Equivalent - Duplicate Degree Credit Not Granted: MATH 3135 or APPM 3310
Requisites: Requires prerequisite course of MATH 2300 or APPM 1360 (minimum grade C-).

MATH 3135 (3) Honors Introduction to Linear Algebra
Examines basic properties of systems of linear equations, vector spaces, inner products, linear independence, dimension, linear transformations, matrices, determinants, eigenvalues, eigenvectors and diagonalization.
Equivalent - Duplicate Degree Credit Not Granted: MATH 3130 or APPM 3310
Requisites: Requires a prerequisite course of MATH 2300 or APPM 1360 and MATH 2001 (all minimum grade C-).

MATH 3140 (3) Abstract Algebra 1
Studies basic properties of algebraic structures with a heavy emphasis on groups. Other topics, time permitting, may include rings and fields.
Requisites: Requires prerequisite courses of (MATH 2001 or MATH 2002) and (MATH 2130 or MATH 3130 or MATH 2135 or MATH 3135) (all minimum grade C-).

MATH 3170 (3) Combinatorics 1
Covers basic methods and results in combinatorial theory. Includes enumeration methods, elementary properties of functions and relations, and graph theory. Emphasizes applications.
Requisites: Requires prerequisite of MATH 2001 or MATH 2002 (both minimum grade C-).

MATH 3210 (3) Euclidean and Non-Euclidean Geometry
Axiomatic systems; Euclid's presentation of the elements of geometry; Hilbert's axioms; neutral, Euclidean and non-Euclidean geometries and their models.
Requisites: Requires prerequisite courses of (MATH 2001 or MATH 2002) and (MATH 2130 or MATH 3130 or MATH 2135 or MATH 3135) (all minimum grade C-).

MATH 3430 (3) Ordinary Differential Equations
Involves an elementary systematic introduction to first-order scalar differential equations, nth order linear differential equations, and n-dimensional linear systems of first-order differential equations. Additional topics are chosen from equations with regular singular points, Laplace transforms, phase plane techniques, basic existence and uniqueness and numerical solutions. Formerly MATH 4430.
Requisites: Requires prerequisite courses of (MATH 2400 or APPM 2350) and (MATH 2130 or 3130 or MATH 2135 or 3135 or APPM 3310) (all minimum grade C-).

MATH 3450 (3) Introduction to Complex Variables
Theory of functions of one complex variable, including integrals, power series, residues, conformal mapping, and special functions. Formerly MATH 4450.
Requisites: Requires prerequisite courses of MATH 2400 or APPM 2350 (minimum grade C-).

MATH 3510 (3) Introduction to Probability and Statistics
Introduces the basic notions of Probability: random variables, expectation, conditioning, and the standard distributions (Binomial, Poisson, Exponential, Normal). This course also covers the Law of Large Numbers and Central Limit Theorem as they apply to statistical questions: sampling from a random distribution, estimation, and hypothesis testing.
Equivalent - Duplicate Degree Credit Not Granted: MATH 2510 or MATH 4510
Requisites: Requires a prerequisite course of (MATH 2300 or APPM 1360) and (MATH 2001 or MATH 2002) (all minimum grade C-).

MATH 3850 (1) Seminar in Guided Mathematics Instruction
Provides learning assistants with an opportunity to analyze assessment data for formative purposes and develop instructional plans as a result of these analyses. These formative assessment analyses will build on the literature in the learning sciences. Students gain direct experiences interacting with the tools of the trade, especially with actual assessment data and models of instruction. Restricted to learning assistants in Math.
Repeatable: Repeatable for up to 3.00 total credit hours.
Requisites: Requires a corequisite course of EDUC 4610.

MATH 4000 (3) Foundations of Mathematics
Focuses on a complete deductive framework for mathematics and applies it to various areas. Presents Goedel's famous incompleteness theorem about the inherent limitations of mathematical systems. Uses idealized computers to investigate the capabilities and limitations of human and machine computation.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5000
Requisites: Requires prerequisite courses of MATH 3001 or MATH 3140 or MATH 4730 (all minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Arts Humanities

MATH 4001 (3) Analysis 2
Provides a rigorous treatment of infinite series, sequences of functions and an additional topic chosen by the instructor (for example, multivariable analysis, the Lebesgue integral or Fourier analysis).
Equivalent - Duplicate Degree Credit Not Granted: MATH 5001
Requisites: Requires prerequisite course of MATH 3001 (minimum grade C-).

MATH 4120 (3) Introduction to Operations Research
Studies linear and nonlinear programming, the simplex method, duality, sensitivity, transportation and network flow problems, some constrained and unconstrained optimization theory, and the Kuhn-Tucker conditions, as time permits.
Equivalent - Duplicate Degree Credit Not Granted: APPM 5120 and APPM 4120 and MATH 5120
Requisites: Requires prerequisite course of MATH 2130 or 3130 or MATH 2135 or 3135 or APPM 3310 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MATH 4140 (3) Abstract Algebra 2
Explores some topic that builds on material in MATH 3140. Possible topics include (but are not limited to) Galois theory, representation theory, advanced linear algebra or commutative algebra.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5140
Requisites: Requires prerequisite course of MATH 3140 (minimum grade C-).

MATH 4200 (3) Introduction to Topology
Introduces the basic concepts of point set topology. Includes topological spaces, metric spaces, homeomorphisms, connectedness and compactness.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5200
Requisites: Requires prerequisite course of MATH 3001 (minimum grade C-).

MATH 4230 (3) Differential Geometry of Curves and Surfaces
Introduces the modern differential geometry of plane curves, space curves, and surfaces in 3-dimensional space. Topics include the Frenet frame, curvature and torsion for space curves; Gauss and mean curvature for surfaces; Gauss and Codazzi equations, and the Gauss-Bonnet theorem.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5230
Requisites: Requires prerequisite courses of (MATH 2400 or APPM 2350) and (MATH 2001 or 2002) and (MATH 2130 or MATH 3130 or MATH 2135 or MATH 3135) (all minimum grade C-).

MATH 4240 (3) Hilbert Spaces and the Mathematics of Quantum Mechanics
Provides an introduction to Hilbert spaces and their application in quantum mechanics. The primary goal is to prove and understand the so-called spectral theorem, which is crucial for the formulation of quantum mechanics. In addition, some examples from physics will be discussed, such as the quantum harmonic oscillator and the spectrum of the hydrogen atom.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5240
Requisites: Requires prerequisite course of MATH 3001 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MATH 4330 (3) Fourier Analysis
The notion of Fourier analysis, via series and integrals, of periodic and nonperiodic phenomena is central to many areas of mathematics. Develops the Fourier theory in depth and considers such special topics and applications as wavelets, Fast Fourier Transforms, seismology, digital signal processing, differential equations, and Fourier optics.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5330
Requisites: Requires prerequisite course of MATH 3001 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MATH 4440 (3) Mathematics of Coding and Cryptography
Gives an introduction, with proofs, to the algebra and number theory used in coding and cryptography. Basic problems of coding and cryptography are discussed.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5440
Requisites: Requires prerequisite course of MATH 2130 or 3130 or MATH 2135 or 3135 (minimum grade C-).

MATH 4470 (3) Partial Differential Equations
Studies initial, boundary, and eigenvalue problems for the wave, heat, and potential equations. Solution by separation of variables, Green's function, and variational methods.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5470
Requisites: Requires prerequisite courses of MATH 3430 (minimum grade C-).

MATH 4510 (3) Introduction to Probability Theory
Studies axioms, combinatorial analysis, independence and conditional probability, discrete and absolutely continuous distributions, expectation and distribution of functions of random variables, laws of large numbers, central limit theorems, and simple Markov chains if time permits.
Equivalent - Duplicate Degree Credit Not Granted: APPM 3570 or ECEN 3810 or MATH 3510 MATH 5510
Requisites: Requires prerequisite courses of (MATH 2400 or APPM 2350) and (MATH 2130 or 3130 or MATH 2135 or 3135) (all minimum grade C-).

MATH 4520 (3) Introduction to Mathematical Statistics
Examines point and confidence interval estimation. Principles of maximum likelihood, sufficiency, and completeness: tests of simple and composite hypotheses, linear models, and multiple regression analysis if time permits. Analyzes various distribution-free methods.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5520 and STAT 4520 and STAT 5520
Requisites: Requires prerequisite course of MATH 4510 or APPM 3570 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MATH 4530 (3) Theoretical Foundations of Data Science
Introduces theoretical concepts from mathematics, statistics, and computer science required to understand and analyze data. Topics include randomized algorithms, machine learning, streaming, sketching, clustering, random matrices and graphs, graphical models and compressed sensing.
Requisites: Requires prerequisite courses of (MATH 2130 or MATH 2135) and MATH 4510 (minimum grade C-).

MATH 4540 (3) Introduction to Time Series
Studies basic properties, trend-based models, seasonal models, modeling and forecasting with ARIMA models, spectral analysis and frequency filtration.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5540 and STAT 4540 and STAT 5540
Requisites: Requires prerequisite course of MATH 4520 or APPM 4520 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

MATH 4650 (3) Intermediate Numerical Analysis 1
Focuses on numerical solution of nonlinear equations, interpolation, methods in numerical integration, numerical solution of linear systems, and matrix eigenvalue problems. Stresses significant computer applications and software. Department enforced prerequisite: knowledge of a programming language.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4650
Requisites: Requires a prerequisite course of MATH 3430 or APPM 2360 and APPM 3310 (minimum grade C-).

MATH 4730 (3) Set Theory
Studies in detail the theory of cardinal and ordinal numbers, definition by recursion, the statement of the continuum hypothesis, simple cardinal arithmetic and other topics chosen by the instructor.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5730
Requisites: Requires prerequisite courses of MATH 3001 or MATH 3110 or MATH 3140 or MATH 3170 or MATH 3210 or MATH 3510 or MATH 4230 (all minimum grade C-).

MATH 4805 (1) Mathematical Teacher Training: Inclusive Pedagogy
Designed to train students to teach mathematics in an inclusive, multicultural environment. Students teach a math course within the McNeill Academic Program (Student Academic Services Center) meeting weekly with faculty and colleagues to learn to re-design curriculum, fine-tune pedagogical practices, create assessments, mentor undergraduate instructor assistants and create an inclusive classroom environment. Department enforced restriction: experience with college-level instruction.
Repeatable: Repeatable for up to 4.00 total credit hours.
Requisites: Restricted to students with 87-180 credits (Seniors) or graduate students only.

MATH 4810 (1-3) Special Topics in Mathematics
Covers various topics not normally covered in the curriculum. Offered intermittently depending on student demand and availability of instructors.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5810
Repeatable: Repeatable for up to 7.00 total credit hours.

MATH 4820 (3) History of Mathematical Ideas
Examines the evolution of a few mathematical concepts (e.g., number, geometric continuum, or proof), with an emphasis on the controversies surrounding these concepts. Begins with Ancient Greek mathematics and traces the development of mathematical concepts through the middle ages into the present.
Equivalent - Duplicate Degree Credit Not Granted: MATH 5820
Requisites: Prerequisite courses of MATH 2001 or MATH 2002 and one of the following: MATH 3001, 3110, 3120, 3140, 3170, 3210, 3430, 3450, 3510, 3850, 4000, 4001, 4120, 4140, 4200, 4230, 4330, 4440, 4510, 4520, 4540, 4650, or 4660 (all min grade C-).
Recommended: completion of upper division Written Communication requirement.
Additional Information: Arts Sci Gen Ed: Distribution-Arts Humanities

MATH 4890 (1-3) Honors Independent Study
Offered for students doing a thesis for departmental honors.
Additional Information: Arts Sciences Honors Course

MATH 4900 (1-3) Independent Study
Repeatable: Repeatable for up to 6.00 total credit hours.

MATH 5000 (3) Foundations of Mathematics
Focuses on a complete deductive framework for mathematics and applies it to various areas. Presents Goedel's famous incompleteness theorem about the inherent limitations of mathematical systems. Uses idealized computers to investigate the capabilities and limitations of human and machine computation. Department enforced prerequisites: MATH 2130 and MATH 3140.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4000
Requisites: Restricted to graduate students only.

MATH 5001 (3) Analysis 2
Provides a rigorous treatment of infinite series, sequences of functions and an additional topic chosen by the instructor (for example, multivariable analysis, the Lebesgue integral or Fourier analysis).
Equivalent - Duplicate Degree Credit Not Granted: MATH 4001
Requisites: Restricted to graduate students only.

MATH 5030 (3) Intermediate Mathematical Physics 1
Surveys classical mathematical physics, starting with complex variable theory and finite dimensional vector spaces. Discusses topics in ordinary and partial differential equations, the special functions, boundary value problems, potential theory, and Fourier analysis. Department enforced prerequisite: MATH 4001. Instructor consent required for undergraduates.
Equivalent - Duplicate Degree Credit Not Granted: PHYS 5030
Requisites: Restricted to graduate students only.

MATH 5040 (3) Intermediate Mathematical Physics 2
Surveys classical mathematical physics, starting with complex variable theory and finite dimensional vector spaces. Discusses topics in ordinary and partial differential equations, the special functions, boundary value problems, potential theory and Fourier analysis. Department enforced prerequisite: MATH 5030.
Equivalent - Duplicate Degree Credit Not Granted: PHYS 5040
Requisites: Restricted to graduate students only.

MATH 5120 (3) Introduction to Operations Research
Studies linear and nonlinear programming, the simplex method, duality, sensitivity, transportation and network flow problems, some constrained and unconstrained optimization theory, and the Kuhn-Tucker conditions, as time permits.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4120 and MATH 4120 and APPM 5120
Requisites: Restricted to graduate students only.
Recommended: Prerequisites APPM 3310 OR MATH 2130 OR MATH 2135 or equivalent.

MATH 5140 (3) Abstract Algebra 2
Explores some topic that builds on material in MATH 3140. Possible topics include (but are not limited to) Galois theory, representation theory, advanced linear algebra or commutative algebra. Department enforced prerequisite: MATH 3140.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4140
Requisites: Restricted to graduate students only.

MATH 5150 (3) Linear Algebra
Highlights vector spaces, linear transformations, eigenvalues and eigenvectors, and canonical forms. Department enforced prerequisite: MATH 2130 or MATH 2135. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 5200 (3) Introduction to Topology
Introduces the basic concepts of point set topology. Includes topological spaces, metric spaces, homeomorphisms, connectedness and compactness.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4200

MATH 5230 (3) Differential Geometry of Curves and Surfaces
Introduces the modern differential geometry of plane curves, space curves, and surfaces in 3-dimensional space. Topics include the Frenet frame, curvature and torsion for space curves; Gauss and mean curvature for surfaces; Gauss and Codazzi equations, and the Gauss-Bonnet theorem.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4230
Requisites: Restricted to graduate students only.

MATH 5240 (3) Hilbert Spaces and the Mathematics of Quantum Mechanics
Provides an introduction to Hilbert spaces and their application in quantum mechanics. The primary goal is to prove and understand the so-called spectral theorem, which is crucial for the formulation of quantum mechanics. In addition, some examples from physics will be discussed, such as the quantum harmonic oscillator and the spectrum of the hydrogen atom.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4240
Requisites: Restricted to graduate students only.

MATH 5330 (3) Fourier Analysis
The notion of Fourier analysis, via series and integrals, of periodic and nonperiodic phenomena is central to many areas of mathematics. Develops the Fourier theory in depth and considers such special topics and applications as wavelets, Fast Fourier Transforms, seismology, digital signal processing, differential equations, and Fourier optics. Department enforced prerequisite: MATH 4001.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4330
Requisites: Restricted to graduate students only.

MATH 5430 (3) Ordinary Differential Equations
Introduces theory and applications of ordinary differential equations, including existence and uniqueness theorems, qualitative behavior, series solutions, and numerical methods, for scalar equations and systems. Department enforced prerequisites: MATH 2130 and MATH 3001. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 5440 (3) Mathematics of Coding and Cryptography
Gives an introduction, with proofs, to the algebra and number theory used in coding and cryptography. Basic problems of coding and cryptography are discussed; prepares students for the more advanced ECEN 5682.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4440
Requisites: Restricted to graduate students only.

MATH 5470 (3) Partial Differential Equations
Studies initial boundary and eigenvalue problems for the wave, heat and potential equations. Solution by separation of variables, Green's function, and variational methods. Department enforced prerequisite: MATH 3430 or MATH 5430. Instructor consent required for undergraduates.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4470
Requisites: Restricted to graduate students only.

MATH 5510 (3) Introduction to Probability Theory
Studies axioms, combinatorial analysis, independence and conditional probability, discrete and absolutely continuous distributions, expectation and distribution of functions of random variables, laws of large numbers, central limit theorems, and simple Markov chains if time permits.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4510
Requisites: Restricted to graduate students only.

MATH 5520 (3) Introduction to Mathematical Statistics
Examines point and confidence interval estimation. Principles of maximum likelihood, sufficiency, and completeness: tests of simple and composite hypotheses, linear models, and multiple regression analysis if time permits. Analyzes various distribution-free methods. Department enforced prerequisite: one semester calculus-based probability course, such as MATH 4510 or APPM 3570.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4520 and MATH 4520 and STAT 5520
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to APPM 3570 or STAT 3100 or MATH 4510; minimum grade of C- for all.

MATH 5540 (3) Introduction to Time Series
Studies basic properties, trend-based models, seasonal models modeling and forecasting with ARIMA models, spectral analysis and frequency filtration. Department enforced prerequisite: APPM 5520 or MATH 5520.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4540 and MATH 4540 and STAT 5540
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to STAT 4520 or MATH 4520 or STAT 5520 or MATH 5520; minimum grade of C- for all.

MATH 5600 (3) Numerical Analysis 1
Solution of nonlinear algebraic equations, interpolation, approximation theory and numerical integration. Department enforced prerequisites: MATH 2130 or MATH 2135 or APPM 3310 and experience with a scientific programming language. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 5610 (3) Numerical Analysis 2
Solution of linear systems, eigenvalue problems, optimization problems, and ordinary and partial differential equations. Department enforced prerequisite: MATH 5600 or APPM 5600. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 5730 (3) Set Theory
Studies in detail the theory of cardinal and ordinal numbers, definition by recursion, the statement of the continuum hypothesis, simple cardinal arithmetic and other topics chosen by the instructor.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4730

MATH 5810 (1-3) Special Topics in Mathematics
Covers various topics not normally covered in the curriculum. Offered intermittently depending on student demand and availability of instructors.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4810
Repeatable: Repeatable for up to 7.00 total credit hours.
Requisites: Restricted to graduate students only.

MATH 5820 (3) History of Mathematical Ideas
Examines the evolution of a few mathematical concepts (e.g., number, geometric continuum, or proof), with an emphasis on the controversies surrounding these concepts. Begins with Ancient Greek mathematics and traces the development of mathematical concepts through the middle ages into the present.
Equivalent - Duplicate Degree Credit Not Granted: MATH 4820
Requisites: Restricted to graduate students only.
Recommended: Requisite completion of upper division Written Communication requirement.

MATH 5905 (1) Mathematics Teacher Training
Designed to train students to become effective teachers. Students teach a mathematics course, meeting weekly with faculty to discuss problems particular to the teaching of mathematics. Department enforced prerequisite: current employment as a teaching assistant.
Requisites: Restricted to graduate students only.

MATH 6000 (3) Model Theory
Proves the compactness theorem, showing the essential finiteness of logical implication. Proves many basic properties of theories, showing how the syntactic form of statements influences their behavior w.r.t., different models. Finally, studies properties of elements that cannot be stated by a single formula (the type of the element) and shows it can be used to characterize certain models.
Requisites: Restricted to graduate students only.

MATH 6010 (3) Computability Theory
Studies the computable and uncomputable. Shows that there are undecidable problems and from there builds up the theory of sets of natural numbers under Turing reducibility. Studies Turing reducibility, the arithmetical hierarchy, oracle constructions and end with the finite injury priority method. Department enforced prerequisite: MATH 6000.
Requisites: Restricted to graduate students only.

MATH 6020 (3) Category Theory
Studies categories, functors, natural transformations, adjoints, and universal constructions. Special topics may include monads and their algebras, abelian categories, Kan extensions, or sheaves in geometry and logic. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6110 (3) Introduction to Number Theory
Examines divisibility properties of integers, congruences, diophantine equations, arithmetic functions, quadratic residues, distribution of primes and algebraic number fields. Department enforced prerequisite: MATH 3140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6130 (3) Algebra 1
Studies group theory and ring theory. Department enforced prerequisite: MATH 3140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6140 (3) Algebra 2
Studies modules, fields and Galois theory. Department enforced prerequisite: MATH 6130. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6150 (3) Commutative Algebra
Introduces topics used in number theory and algebraic geometry, including radicals of ideals, exact sequences of modules, tensor products, Ext, Tor, localization, primary decomposition of ideals and Noetherian rings. Department enforced prerequisite: MATH 6140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6170 (3) Algebraic Geometry
Introduces algebraic geometry, including affine and projective varieties, rational maps and morphisms and differentials and divisors. Additional topics might include Bezout's Theorem, the Riemann-Roch Theorem, elliptic curves, and sheaves and schemes. Department enforced prerequisite: MATH 6140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6175 (3) Algebraic Geometry 2
Continuation of MATH 6170. Develops algebraic geometry using schemes. Topics include coherent and quasicoherent sheaves, sheaf cohomology, Serre duality, lifting criteria, smoothness, base change theorems, algebraic curves and surfaces, and additional topics at the discretion of the instructor. Instructor consent required for undergraduates. Department enforced prerequisite: MATH 6170.
Requisites: Restricted to graduate students only.
Recommended: Prerequisites MATH 6150 or MATH 6290.

MATH 6180 (3) Algebraic Number Theory
Introduces number fields and completions, norms, discriminants and differents, finiteness of the ideal class group, Dirichlet's unit theorem, decomposition of prime ideals in extension fields, decomposition and ramification groups. Department enforced prerequisites: MATH 6110 and MATH 6140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6190 (3) Analytic Number Theory
Acquaints students with the Riemann Zeta-function and its meromorphic continuation, characters and Dirichlet series, Dirichlet's theorem on primes in arithmetic progressions, zero-free regions of the zeta function and the prime number theorem. Department enforced prerequisites: MATH 6110 and MATH 6350. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6210 (3) Introduction to Topology 1
Introduces elements of point-set topology and algebraic topology, including the fundamental group and elements of homology. Department enforced prerequisites: MATH 2130 and MATH 3140 and MATH 4001. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6220 (3) Introduction to Topology 2
Continuation of MATH 6210. Department enforced prerequisite: MATH 6210. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6230 (3) Introduction to Differential Geometry 1
Introduces topological and differential manifolds, vector bundles, differential forms, de Rham cohomology, integration, Riemannian metrics, connections and curvature. Department enforced prerequisites: MATH 2130 and MATH 4001. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6240 (3) Introduction to Differential Geometry 2
Continuation of MATH 6230. Department enforced prerequisite: MATH 6230. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6250 (3) Theory of Rings
Studies semi-simple Artinian rings, the Jacobson radical, group rings, representations of finite groups, central simple algebras, division rings and the Brauer group. Department enforced prerequisites: MATH 6130 and MATH 6140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6260 (3) Geometry of Quantum Fields and Strings
Focuses on differential geometric techniques in quantum field and string theories. Topics include: spinors, Dirac operators, index theorem, anomalies, geometry of superspace, supersymmetric quantum mechanics and field theory and nonperturbative aspects in field and string theories. Department enforced prerequisites: MATH 6230 and MATH 6240 and PHYS 5250 and PHYS 7280. Instructor consent required for undergraduates.
Equivalent - Duplicate Degree Credit Not Granted: PHYS 6260
Requisites: Restricted to graduate students only.

MATH 6270 (3) Theory of Groups
Studies nilpotent and solvable groups, simple linear groups, multiply transitive groups, extensions and cohomology, representations and character theory, and the transfer and its applications. Department enforced prerequisites: MATH 6130 and MATH 6140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6280 (3) Advanced Algebraic Topology
Covers homotopy theory, spectral sequences, vector bundles, characteristic classes, K-theory and applications to geometry and physics. Department enforced prerequisite: MATH 6220. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6290 (3) Homological Algebra
Studies categories and functors, abelian categories, chain complexes, derived functors, Tor and Ext, homological dimension, group homology and cohomology. If time permits, the instructor may choose to cover additional topics such as spectral sequences or Lie algebra homology and cohomology. Department enforced prerequisites: MATH 6130 and MATH 6140.
Requisites: Restricted to graduate students only.

MATH 6310 (3) Introduction to Real Analysis 1
Develops the theory of Lebesgue measure and the Lebesgue integral on the line, emphasizing the various notions of convergence and the standard convergence theorems. Applications are made to the classical L^p spaces. Department enforced prerequisite: MATH 4001. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6320 (3) Introduction to Real Analysis 2
Covers general metric spaces, the Baire Category Theorem, and general measure theory, including the Radon-Nikodym and Fubini theorems. Presents the general theory of differentiation on the real line and the Fundamental Theorem of Lebesgue Calculus. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.
Recommended: Prerequisite MATH 6310.

MATH 6350 (3) Functions of a Complex Variable 1
Focuses on complex numbers and the complex plane. Includes Cauchy-Riemann equations, complex integration, Cauchy integral theory, infinite series and products, and residue theory. Department enforced prerequisite: MATH 4001. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6360 (3) Functions of a Complex Variable 2
Focuses on conformal mapping, analytic continuation, singularities and elementary special functions. Department enforced prerequisite: MATH 6350. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6534 (3) Topics in Mathematical Probability
Offers selected topics in probability such as sums of independent random variables, notions of convergence, characteristic functions, Central Limit Theorem, random walk, conditioning and martingales, Markov chains and Brownian motion. Department enforced prerequisite: MATH 6310. Instructor consent required for undergraduates
Requisites: Restricted to graduate students only.

MATH 6550 (3) Introduction to Stochastic Processes
Systematic study of Markov chains and some of the simpler Markov processes, including renewal theory, limit theorems for Markov chains, branching processes, queuing theory, birth and death processes, and Brownian motion. Applications to physical and biological sciences. Department enforced prerequisite: MATH 4001 or MATH 4510 or APPM 3570 or APPM 4560. Instructor consent required for undergraduates.
Equivalent - Duplicate Degree Credit Not Granted: APPM 6550
Requisites: Restricted to graduate students only.

MATH 6730 (3) Set Theory
Presents cardinal and ordinal arithmetic, and basic combinatorial concepts, including stationary sets, generalization of Ramsey's theorem, and ultrafilters, consisting of the axiom of choice and the generalized continuum hypothesis. Department enforced prerequisites: MATH 4000 or MATH 5000 and MATH 4730 or MATH 5730. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6740 (3) Forcing
Presents independence of the axiom of choice and the continuum hypothesis, Souslin's hypothesis and other applications of the method of forcing. Introduces the theory of large cardinals. Department enforced prerequisite: MATH 6730. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 6900 (1-3) Independent Study
Instructor consent required for undergraduates.
Repeatable: Repeatable for up to 6.00 total credit hours.
Requisites: Restricted to graduate students only.

MATH 6940 (1) Master's Candidate for Degree
This course is for students preparing for the no-thesis option for a master's degree. The content is set by the students' advisors.
Requisites: Restricted to graduate students only.

MATH 6950 (1-6) Master's Thesis

MATH 8114 (3) Topics in Number Theory
May include the theory of automorphic forms, elliptic curves, or any of a variety of advanced topics in analytic and algebraic number theory. Department enforced prerequisite: MATH 6110. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 8174 (3) Topics in Algebra I
Department enforced prerequisites: MATH 6130 and MATH 6140. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 8210 (3) Topics in Topology
Presents specialized topics in topology such as stable homotopy theory, derived algebraic geometry, Weil cohomology theories, cobordism and topological field theories, theory of stratified spaces, index theory, mixed Hodge modules, topological data analysis. Department enforced prerequisite: MATH 6210 or MATH 5200. Instructor consent required for undergraduates.
Repeatable: Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.

MATH 8234 (3) Topics in Differential Geometry
Presents advanced topics in Differential Geometry, such as index theory, partial differential equations on manifolds, exterior differential systems, and Cartan's methods.
Repeatable: Repeatable for up to 12.00 total credit hours. Allows multiple enrollment in term.
Requisites: Requires prerequisite courses of MATH 6230 and MATH 6310 (minimum grade D-). Restricted to graduate students only. Instructor consent required for undergraduates.

MATH 8250 (3) Mathematical Theory of Relativity 1
Focuses on Maxwell equations, Lorentz force, Minkowski space-time, Lorentz, Poincare, and conformal groups,metric manifolds, covariant differentiation, Einstein space-time, cosmologies, and unified field theories. Instructor consent required.
Requisites: Restricted to graduate students only.

MATH 8304 (3) Topics in Analysis 1
Presents advanced topics in analysis including Lie groups, Banach algebras, operator theory, ergodic theory, representation theory, etc. Department enforced prerequisites: MATH 8330 and MATH 8340. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 8330 (3) Functional Analysis 1
Introduces such topics as Banach spaces (Hahn-Banach theorem, open mapping theorem, etc.), operator theory (compact operators and integral equations and spectral theorem for bounded self-adjoint operators) and Banach algebras (the Gelfand theory). Department enforced prerequisites: MATH 6310 and MATH 6320. Instructor consent required for undergraduates. See also MATH 8340.
Requisites: Restricted to graduate students only.

MATH 8340 (3) Functional Analysis 2
Introduces such topics as Banach spaces (Hahn-Banach theorem, open mapping theorem, etc.), operator theory (compact operators and integral equations and spectral theorem for bounded self-adjoint operators) and Banach algebras (the Gelfand theory). Department enforced prerequisite: MATH 8330. Instructor consent required for undergraduates. See also MATH 8330.
Requisites: Restricted to graduate students only.

MATH 8370 (3) Harmonic Analysis 1
Examines trigonometric series, periodic functions, diophantine approximation and Fourier series. Also covers Bohr and Stepanoff almost periodic functions, positive definite functions and the L^1 and L^2 theory of the Fourier integral. Applications to group theory and differential equations. Department enforced prerequisites: MATH 5150 and MATH 6320. Instructor consent required for undergraduates.
Requisites: Restricted to graduate students only.

MATH 8714 (3) Topics in Logic 1 and 2
Requisites: Restricted to graduate students only.

MATH 8815 (1-3) Ulam Seminar
Repeatable: Repeatable for up to 3.00 total credit hours. Allows multiple enrollment in term.
Requisites: Restricted to graduate students only.

MATH 8900 (1-3) Independent Study
Instructor consent required for undergraduates.
Repeatable: Repeatable for up to 6.00 total credit hours.
Requisites: Restricted to graduate students only.

MATH 8990 (1-10) Doctoral Dissertation
All doctoral students must register for not fewer than 30 hours of dissertation credit as part of the requirements for the degree. For a detailed discussion of doctoral dissertation credit, refer to the Graduate School portion of the catalog.
Requisites: Restricted to graduate students only.