**MATH 96 — PREPARATORY ALGEBRA**
3 credits.

Covers the necessary mathematical tools needed to succeed in our algebra course and provides fundamental mathematical skills. Topics include real numbers, linear equations and inequalities, integral and fractional exponents, polynomials and their arithmetic, polynomial equations and equations with fractional exponents, the quadratic formula and completing the square, systems of two linear equations, graphing, and problem solving using algebra and graphs. All students must pass an assessment on basic mathematical skills to complete the course. The course does not count for degree credit. Enroll Info: None

**Requisites:** Placement into MATH 96. Department consent required to drop/swap from course

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

**MATH 112 — ALGEBRA**
3 credits.

Properties of elementary functions, such as polynomial, absolute value, radical, rational, exponential, and logarithmic functions. Topics include equations, inequalities, functions, and their graphs. Students will formulate, analyze, solve, and interpret mathematical and real-world problems. Intended to provide the algebra skills required for calculus. Enroll Info: None

**Requisites:** MATH 96 or placement into MATH 112. MATH 118 does not fulfill the requisite

**Course Designation:** Gen Ed - Quantitative Reasoning Part A

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

**MATH 113 — TRIGONOMETRY**
3 credits.

Covers the graphs, properties and geometric significance of trigonometric functions of a real variable. Other topics include trigonometric equations and identities, application, trigonometric form of complex numbers, DeMoivre's theorem, and polar and parametric equations. The course also has a significant number of applications, especially related to other disciplines. Enroll Info: None

**Requisites:** MATH 112 or placement into MATH 113

**Course Designation:** Level - Elementary

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

**MATH 114 — ALGEBRA AND TRIGONOMETRY**
5 credits.

The two semester sequence MATH 112-MATH 113 covers similar material as MATH 114, but in a slower pace. Enroll Info: Not recommended for students with less than an AB in MATH 96.

**Requisites:** MATH 96 or placement into MATH 114. MATH 118 does not fulfill the requisite

**Course Designation:** Gen Ed - Quantitative Reasoning Part A

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

**MATH 118 — SUMMER COLLEGIATE EXPERIENCE MATHEMATICS COURSE**
2 credits.

A preparation and introductory math course for students enrolled in the Summer Collegiate Experience program. Includes material from precalculus and calculus and related topics depending on students' results on the math placement exam. Enroll Info: None

**Requisites:** Enrolled in the Summer Collegiate experience program

**Course Designation:** Level - Elementary

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Summer 2016

**MATH 130 — MATHEMATICS FOR TEACHING: NUMBERS AND OPERATIONS**
3 credits.

Mathematics for teaching focusing on numbers and operations in K-8. Emphasis on understanding a variety of problem solving strategies and word problems. Content will focus on place value, models for the operations, standard and alternative algorithms, fractions, and decimals. Enroll Info: None

**Requisites:** MATH 96 or placement into MATH 130 and classified as Elementary Education, Pre-Elementary Education or Pre-Special Education

**Course Designation:** Gen Ed - Quantitative Reasoning Part A

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

**MATH 131 — MATHEMATICS FOR TEACHING: GEOMETRY AND MEASUREMENT**
3 credits.

Mathematics for teaching focusing on geometry and measurement in K-8. Emphasis on understanding a variety of problem solving strategies and deductive reasoning. Content will focus on geometric shapes and their relationships, transformations, measurement, and the connection to numbers. Enroll Info: None

**Requisites:** Grade of C in MATH 130 and classified as Elementary Education, Pre-Elementary Education, or Pre-Special Education

**Course Designation:** Level - Elementary

**L&S Credit:** Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2019
MATH 132 — PROBLEM SOLVING IN ALGEBRA, PROBABILITY AND STATISTICS
3 credits.

Algebra, probability, and statistics for teachers of elementary school mathematics. Topics include proportions, relations, functions and their graphs, equally likely outcomes, expected value, and representation of data. The emphasis is on problem solving, modeling, and analysis of solution strategies. Enroll Info: None
Requisites: MATH 130 and 131 with grades of C or better. Open only to students classified as Elementary Education, Pre-Elementary Education, or Pre-Special Education
Course Designation: Gen Ed - Quantitative Reasoning Part B
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 135 — ALGEBRAIC REASONING FOR TEACHING MATH
3 credits.

Topics from high school/college algebra relevant to teaching mathematics in middle school, including linear and quadratic equations and inequalities, linear systems, concept of a function, exponential and polynomial functions, with an emphasis on problem solving and modeling. Enroll Info: None
Requisites: Grade of C in MATH 130, and (MATH 112, 114, or 171), and classified in Elementary Education, Pre-Elementary Education, or Pre-Special Education
Course Designation: Gen Ed - Quantitative Reasoning Part B
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 136 — PRE-CALCULUS AND CALCULUS FOR MIDDLE SCHOOL TEACHERS
6 credits.

Designed to develop future middle school mathematics teachers’ knowledge of precalculus and calculus concepts and to make connections between these concepts and middle school mathematics. Enroll Info: None
Requisites: Grade of C in MATH 135 and declared in Elementary Education or special student standing
Course Designation: Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2015

MATH 138 — MATHEMATICS FOR TEACHING: CONJECTURE, GENERALIZATION, AND PROOF
3 credits.

Explores the roles of conjecture, generalization, and proof in effective teaching of mathematics. Students explore mathematical reasoning as an iterative process of conjecturing, generalizing and investigating. Topics are drawn from counting, probability, statistics, arithmetic, algebra, and geometry. Enroll Info: None
Requisites: Grade of C in MATH 136 and declared in Elementary Education
Course Designation: Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 141 — QUANTITATIVE REASONING AND PROBLEM SOLVING
3 credits.

Develops a habit of mind, competency, and comfort in working with numerical data. Learn to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations, develop the ability to reason mathematically, and make and evaluate logical arguments supported by quantitative evidence. Enroll Info: This course is for students who need to satisfy part A of the Quantitative Reasoning requirement and prepare for QR-B courses, but do not want to continue in the calculus sequence.
Requisites: MATH 96 or placement into MATH 141. MATH 118 does not fulfill the requisite
Course Designation: Gen Ed - Quantitative Reasoning Part A
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 171 — CALCULUS WITH ALGEBRA AND TRIGONOMETRY I
5 credits.

Topics in algebra, trigonometry and precalculus are integrated with elementary differential calculus. Part of a 2-semester sequence with MATH 217; these two courses together are equivalent to MATH 114 and 221. Enroll Info: None
Requisites: MATH 96 or placement into MATH 171. MATH 118 does not fulfill the requisite
Course Designation: Gen Ed - Quantitative Reasoning Part A
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 198 — DIRECTED STUDY
1-3 credits.

Directed study projects as arranged with a faculty member. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2012
MATH 207 — TOPICS IN MATHEMATICS STUDY ABROAD
1-5 credits.

Credit is awarded to students who have completed an appropriate math course abroad at the intermediate level having no direct equivalence within the math department offerings. Enroll Info: The study abroad course must be pre-approved by the math department.

Requisites: None
Course Designation: Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions

MATH 211 — CALCULUS
5 credits.

Essential concepts of differential and integral calculus; exponential and logarithmic functions; functions of several variables. Enroll Info: Primarily for students in prebusiness and some social sciences. Students preparing for advanced study in mathematics, physics, engineering and other sciences should take MATH 221, 222 and 234 rather than MATH 210, 211 and 213. Most students in the biological sciences should take MATH 221. MATH 210 does not fulfill the requisite.

Requisites: MATH 112 or 114 or placement into MATH 211
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 213 — CALCULUS AND INTRODUCTION TO DIFFERENTIAL EQUATIONS
3 credits.

Techniques of integration, multiple integrals, infinite sequences and series, first order differential equations, two-dimensional systems of differential equations, difference equations, with models from and applications in business and the social and biological sciences. Enroll Info: None

Requisites: MATH 211, 217, 221, or 275
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 217 — CALCULUS WITH ALGEBRA AND TRIGONOMETRY II
5 credits.

Continuation of MATH 171. Topics in algebra, trigonometry and precalculus are integrated with elementary differential calculus. Enroll Info: Completion of MATH 217 implies completion of MATH 221 and 114.

Requisites: MATH 171
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 221 — CALCULUS AND ANALYTIC GEOMETRY 1
5 credits.

Introduction to differential and integral calculus and plane analytic geometry; applications; transcendental functions. Enroll Info: None

Requisites: MATH 114 or (MATH 112 and 113) or placement into MATH 221. MATH 211 or MATH 213 does not fulfill the requisite.

Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 222 — CALCULUS AND ANALYTIC GEOMETRY 2
4 credits.

Techniques of integration, improper integrals, first order ordinary differential equations, sequences and series, Taylor series, vector geometry in two and three dimensions. Enroll Info: None

Requisites: MATH 217, 221, or 275. MATH 211 or 213 does not fulfill the requisite.

Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 228 — WES CALCULUS SUPPLEMENT
2 credits.

Topics in algebra, trigonometry, differential, integral and multi-variable calculus and analytic geometry will be covered depending on which calculus course MATH 228 is attached to. Enroll Info: MATH 228 must be taken in conjunction with the appropriate WES section of MATH 171, 217, 221, 222, or 234.

Requisites: Member of Wisconsin Emerging Scholars--MATH Program

Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 234 — CALCULUS--FUNCTIONS OF SEVERAL VARIABLES
4 credits.

Introduction to calculus of functions of several variables; calculus on parameterized curves, derivatives of functions of several variables, multiple integrals, vector calculus. Enroll Info: None

Requisites: MATH 222 or 276
Course Designation: Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019
MATH/COMP SCI 240 — INTRODUCTION TO DISCRETE MATHEMATICS
3 credits.
Basic concepts of logic, sets, partial order and other relations, and functions. Basic concepts of mathematics (definitions, proofs, sets, functions, and relations) with a focus on discrete structures: integers, bits, strings, trees, and graphs. Propositional logic, Boolean algebra, and predicate logic. Mathematical induction and recursion. Invariants and algorithmic correctness. Recurrences and asymptotic growth analysis. Fundamentals of counting. Enroll Info: None
Requisites: MATH 217, 221, or 275
Course Designation: Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 275 — TOPICS IN CALCULUS I
5 credits.
Topics in first semester calculus. Enroll Info: This is the first semester of the calculus honors sequence. Course is available by invitation only for freshmen students who placed into MATH 221.
Requisites: Consent of instructor
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2014

MATH 276 — TOPICS IN CALCULUS II
5 credits.
Topics in second semester calculus. Enroll Info: This is the second semester of the calculus honors sequence.
Requisites: MATH 275
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2015

MATH 298 — DIRECTED STUDY IN MATHEMATICS
1-3 credits.
Directed study projects as arranged with a faculty member. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2017

MATH/ACT SCI 303 — THEORY OF INTEREST AND LIFE INSURANCE
3 credits.
Application of calculus to compound interest and insurance functions; interest compounded discretely and continuously; force of interest function; annuities payable discretely and continuously; bonds and yield rates; life tables, life annuities, single and annual premiums for insurance and annuities; reserves. Enroll Info: None
Requisites: MATH 222 or 276 or member of Business Exchange program
Course Designation: Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/STAT 309 — INTRODUCTION TO PROBABILITY AND MATHEMATICAL STATISTICS I
3 credits.
Probability and combinatorial methods, discrete and continuous, univariate and multivariate distributions, expected values, moments, normal distribution and derived distributions, estimation. Enroll Info: None
Requisites: MATH 234 or concurrent enrollment; not open to students with credit for STAT/MATH 431 or STAT 311
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/STAT 310 — INTRODUCTION TO PROBABILITY AND MATHEMATICAL STATISTICS II
3 credits.
Mathematical statistical inference aims at providing an understanding of likelihood’s central role to statistical inference, using the language of mathematical statistics to analyze statistical procedures, and using the computer as a tool for understanding statistics. Specific topics include: samples and populations, estimation, hypothesis testing, and theoretical properties of statistical inference. Enroll Info: None
Requisites: (STAT/MATH 309, STAT 311, or STAT/MATH 431) and (STAT 224, STAT 301, STAT 302, STAT 324, STAT 371, or ECON 310); or graduate/professional standing
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 319 — TECHNIQUES IN ORDINARY DIFFERENTIAL EQUATIONS
3 credits.
Review of linear differential equations; series solution of linear differential equations; boundary value problems; Laplace transforms; possibly numerical methods and two dimensional autonomous systems. Enroll Info: None
Requisites: MATH 222 or 276 or graduate/professional standing
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019
MATH 320 — LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS
3 credits.

Introduction to linear algebra, including matrices, linear transformations, eigenvalues and eigenvectors. Linear systems of differential equations. Numerical aspects of linear problems. Prospective math majors should instead consider MATH 341 for a proof based introductory linear algebra course. Enroll Info: None
Requisites: MATH 222 or 276 or graduate/professional standing
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 321 — APPLIED MATHEMATICAL ANALYSIS
3 credits.

Vector analysis: algebra and geometry of vectors, vector differential and integral calculus, theorems of Green, Gauss, and Stokes; complex analysis: analytic functions, complex integrals and residues, Taylor and Laurent series. Enroll Info: None
Requisites: MATH 376, (MATH 234 and 319), (MATH 234 and 320), (MATH 234 and 340), (MATH 234 and 341), (MATH 234 and 375), or graduate/professional standing
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 322 — APPLIED MATHEMATICAL ANALYSIS
3 credits.

Sturm-Liouville theory; Fourier series, including mean convergence; boundary value problems for linear second order partial differential equations, including separation of variables and eigenfunction expansions. Enroll Info: None
Requisites: MATH 321 or 376 or graduate/professional standing
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 331 — AN INTRODUCTION TO PROBABILITY AND MARKOV CHAIN MODELS
3 credits.

An overview of basic probability including discrete and continuous random variables, moment generating functions, limit theorems, conditional probability and expectations, random walks, and Markov chains. Enroll Info: None
Requisites: MATH 234 or (MATH 222 and MATH/COMP SCI 240)
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2013

MATH 340 — ELEMENTARY MATRIX AND LINEAR ALGEBRA
3 credits.

Matrix algebra, linear systems of equations, vector spaces, sub-spaces, linear dependence, rank of matrices, determinants, linear transformations, eigenvalues and eigenvectors, diagonalization, inner products and orthogonal vectors, symmetric matrices. Prospective math majors should instead consider MATH 341 for a proof based introductory linear algebra course. Enroll Info: None
Requisites: MATH 222. Not open to students with credit for MATH 341 or 375
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 341 — LINEAR ALGEBRA
3 credits.

Emphasizes the understanding of concepts in linear algebra and teaches to write and understand proofs in mathematics in general and in linear algebra in particular. Enroll Info: None
Requisites: MATH 234
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 375 — TOPICS IN MULTI-VARIABLE CALCULUS AND LINEAR ALGEBRA
5 credits.

Vector spaces and linear transformations, differential calculus of scalar and vector fields, determinants, eigenvalues and eigenvectors, multiple integrals, line integrals, and surface integrals. Enroll Info: Freshmen students are invited to enroll by the Department of Mathematics.
Requisites: Consent of Instructor
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 376 — TOPICS IN MULTI-VARIABLE CALCULUS AND DIFFERENTIAL EQUATIONS
5 credits.

Topics in multi-variable calculus and introduction to differential equations. Enroll Info: None
Requisites: MATH 375
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019
MATH 407 — TOPICS IN MATHEMATICS STUDY ABROAD
1-5 credits.

Credit is awarded to students who have completed an appropriate math course abroad at the advanced level having no direct equivalence within the math department offerings. The study abroad course must be pre-approved by the math department. Enroll Info: None
Requisites: None
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions

MATH 415 — APPLIED DYNAMICAL SYSTEMS, CHAOS AND MODELING
3 credits.

An introduction to nonlinear dynamical systems including stability, bifurcations and chaos. The course will give underlying mathematical ideas, but emphasize applications from many scientific fields. Enroll Info: None
Requisites: MATH 376, (MATH 234 and 319), (MATH 234 and 320), (MATH 234 and 340), (MATH 234 and 341) or (MATH 234 and 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 421 — THE THEORY OF SINGLE VARIABLE CALCULUS
3 credits.

Covers material in first and second semester calculus but it is intended to teach math majors to write and understand proofs in mathematics in general and in calculus in particular. Enroll Info: None
Requisites: MATH 234 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/COMP SCI/ECE 425 — INTRODUCTION TO MODERN ALGEBRA
3 credits.

The integers, emphasizing general group and ring properties. Permutation groups, symmetry groups, polynomial rings, leading to notions of abstract groups and rings. Congruences, computations, including finite fields and applications. Emphasis on concepts and concrete examples and computations. Enroll Info: None
Requisites: (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/STAT 431 — INTRODUCTION TO THE THEORY OF PROBABILITY
3 credits.

Topics covered include axioms of probability, random variables, the most important discrete and continuous probability distributions, expectation and variance, moment generating functions, conditional probability and conditional expectations, multivariate distributions, Markov's and Chebyshev's inequalities, laws of large numbers, and the central limit theorem. Enroll Info: None
Requisites: MATH 234 or 376 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/COMP SCI/ECE 435 — INTRODUCTION TO CRYPTOGRAPHY
3 credits.

Cryptography is the art and science of transmitting digital information in a secure manner. Provides an introduction to its technical aspects. Enroll Info: None
Requisites: (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 441 — INTRODUCTION TO THE THEORY OF PROBABILITY
3 credits.

Topics covered include axioms of probability, random variables, the most important discrete and continuous probability distributions, expectation and variance, moment generating functions, conditional probability and conditional expectations, multivariate distributions, Markov's and Chebyshev's inequalities, laws of large numbers, and the central limit theorem. Enroll Info: None
Requisites: MATH 234 or 376 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019
MATH 461 — COLLEGE GEOMETRY I
3 credits.

An introduction to Euclidean or non-Euclidean geometry. Enroll Info: None
Requisites: MATH 234 or (MATH 222 and COMP SCI/MATH 240) or MATH 375 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 467 — INTRODUCTION TO NUMBER THEORY
3 credits.

An introduction to proof writing techniques through a study of classical topics in elementary number theory. Topics include the divisibility, basic properties of primes, congruences, Fermat’s theorem. Enroll Info: None
Requisites: MATH 234, 375, (222 and COMP SCI/MATH 240), (222 and 320), or (222 and 340)
Course Designation: Breadth - Natural Science
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No

MATH/CURRIC 471 — MATHEMATICS FOR SECONDARY SCHOOL TEACHERS
3 credits.

This is a capstone course for future middle and high school teachers, drawing connections between higher mathematics and school mathematics. Enroll Info: None
Requisites: (MATH 341, 375, or 421) and MATH 461
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/HIST SCI 473 — HISTORY OF MATHEMATICS
3 credits.

An historical survey of the main lines of mathematical development. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Breadth - Either Humanities or Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/COMP SCI/STAT 475 — INTRODUCTION TO COMBINATORICS
3 credits.

Requisites: (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 490 — UNDERGRADUATE SEMINAR
1-3 credits.

Intermediate or upper level topics course in mathematics. Topics vary. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 491 — TOPICS IN UNDERGRADUATE MATHEMATICS
3 credits.

Intermediate or upper level topics course in mathematics. Topics vary. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2016

MATH/COMP SCI 513 — NUMERICAL LINEAR ALGEBRA
3 credits.

Requisites: (MATH 340, 341, or 375) and (COMP SCI 200, 300, 301, 302 or 310) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019
MATH/COMP SCI 514 — NUMERICAL ANALYSIS
3 credits.


Requisites: (MATH 320, 340, 341, or 375) and (MATH 322, 376, 421, or 521) and (COMP SCI 200, 300, 301, or 310) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 519 — ORDINARY DIFFERENTIAL EQUATIONS
3 credits.

Provides a rigorous introduction to ordinary differential equations and dynamical systems. Enroll Info: Intended for math majors and advanced (or graduate) students in other disciplines.

Requisites: (MATH 320, 340, 341, or 375) and (MATH 322, 376, 421, or 521) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 521 — ANALYSIS I
3 credits.

The real numbers, elements of set theory, metric spaces and basic topology, sequences and series, limits, continuity, differentiation, integration, sequences and series of functions, uniform convergence. Enroll Info: None

Requisites: MATH 322, 341, 376, or 421 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 522 — ANALYSIS II
3 credits.

Special functions, power series, Fourier series, approximation, contraction principle, characterizations of compactness in metric spaces, applications to differential equations. Differential calculus in normed spaces, including implicit and inverse function theorems. Course is essential for graduate work in mathematics. Enroll Info: None

Requisites: MATH 521 and (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/COMP SCI/I SY E/STAT 525 — LINEAR PROGRAMMING METHODS
3 credits.

Real linear algebra over polyhedral cones; theorems of the alternative for matrices. Formulation of linear programs. Duality theory and solvability. The simplex method and related methods for efficient computer solution. Perturbation and sensitivity analysis. Applications and extensions, such as game theory, linear economic models, and quadratic programming. Enroll Info: None

Requisites: MATH 320, 340, 341, 375, or 443 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 531 — PROBABILITY THEORY
3 credits.

A rigorous introduction to probability theory at an advanced undergraduate level. Only a minimal amount of measure theory is used, in particular, the theory of Lebesgue integrals is not needed. It is aimed at math majors and Master’s degree students, or students in other fields who will need probability in their future careers. Gives an introduction to the basics (Kolmogorov axioms, conditional probability and independence, random variables, expectation) and discusses some classical results with proofs (DeMoivre-Laplace limit theorems, the study of simple random walk on the one dimensional lattice, applications of generating functions). Enroll Info: None

Requisites: MATH 376, 421, or 521 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019
MATH 540 — LINEAR ALGEBRA II
3 credits.
Requisites: (MATH 341 or 375) or (MATH 320 and MATH 421, 521, 541, or 551) or (MATH 340 and MATH 421, 521, 541, or 551)
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 541 — MODERN ALGEBRA
3 credits.
Groups, normal subgroups, Cayley's theorem, rings, ideals, homomorphisms, polynomial rings, abstract vector spaces. Enroll Info: None
Requisites: MATH 341, 375, (MATH 421 and 320), (MATH 421 and 340), (MATH 521 and 320), (MATH 521 and 340) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 542 — MODERN ALGEBRA
3 credits.
Field extensions, roots of polynomials, splitting fields, simple extensions, linear transformations, matrices, characteristic roots, canonical forms, determinants. Enroll Info: None
Requisites: MATH 541 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 551 — ELEMENTARY TOPOLOGY
3 credits.
Topological spaces, connectedness, compactness, separation axioms, metric spaces. Enroll Info: None
Requisites: MATH 341, 375, (MATH 421 and 320), (MATH 421 and 340), (MATH 521 and 320), (MATH 521 and 340) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 552 — ELEMENTARY GEOMETRIC AND ALGEBRAIC TOPOLOGY
3 credits.
Introduction to algebraic topology. Emphasis on geometric aspects, including two-dimensional manifolds, the fundamental group, covering spaces, basic simplicial homology theory, the Euler-Poincare formula, and homotopy classes of mappings. Enroll Info: None
Requisites: (MATH 551 and 541) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 561 — DIFFERENTIAL GEOMETRY
3 credits.
Theory of curves and surfaces by differential methods. Enroll Info: None
Requisites: MATH 320, 340, 341, or 375) and (MATH 322, 376, 421, or 521) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 567 — ELEMENTARY NUMBER THEORY
3 credits.
Fundamental theorem of arithmetic, quadratic residues and quadratic reciprocity, number-theoretic functions, certain diophantine equations, Farey fractions, continued fractions. Enroll Info: None
Requisites: (MATH 320, 340, 341, or 375) and (MATH 322, 376, 421, or 521) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018
MATH 570 — FUNDAMENTALS OF SET THEORY
3 credits.

Introduces the basic concepts of Set Theory including: Set-theoretical paradoxes and means of avoiding them, sets, relations, functions, orders and well-orders, proof by transfinite induction and definitions by transfinite recursion, cardinal and ordinal numbers and their arithmetic, construction of the real numbers, the axiom of choice and its consequences. Enroll Info: None

Requisites: MATH 341, 375, 421, 521 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2018

MATH/PHILOS 571 — MATHEMATICAL LOGIC
3 credits.

Basics of logic and mathematical proofs; propositional logic; first order logic; undecidability. Enroll Info: None

Requisites: MATH 341, 375, 421, 521 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Either Humanities or Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MATH 605 — STOCHASTIC METHODS FOR BIOLOGY
3 credits.

Intended to provide a rigorous foundation for stochastic modeling of biological systems. The mathematical emphasis is in stochastic analysis and simulation. Biological applications include epidemiological phenomena, biochemical reaction networks and population dynamics. Enroll Info: None

Requisites: (STAT/MATH 431, 309, STAT 311 or MATH 531) and (MATH 320, 340, 341, 375, 421 or 531) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2015

MATH/B M I/BIOCHEM/BMOLCHEM 606 — MATHEMATICAL METHODS FOR STRUCTURAL BIOLOGY
3 credits.

A rigorous foundation for mathematical modeling of biological structures. Mathematical techniques include ordinary and partial differential equations, 3D Fourier analysis and optimization. Biological applications include protein folding, molecular dynamics, implicit solvent electrostatics, and molecular interactions. Enroll Info: None

Requisites: (MATH 234, 320, 340, or 375) and (COMP SCI 200, 300, 301, 302, or 310) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2016

MATH 607 — TOPICS IN MATHEMATICS STUDY ABROAD
1-5 credits.

Credit is awarded to students who have completed an appropriate math course abroad at the advanced level having no direct equivalence within the math department offerings. Enroll Info: The study abroad course must be pre-approved by the math department.

Requisites: None

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions

MATH 608 — MATHEMATICAL METHODS FOR CONTINUUM MODELING IN BIOLOGY
3 credits.

Provides a rigorous foundation for mathematical modeling of biological systems. The mathematical emphasis is on partial differential equations, particularly reaction-diffusion and transport equations. Biological applications include bacterial chemotaxis, spatio-temporal ecological dynamics, and cell-level reactions. Enroll Info: None

Requisites: MATH 322 and (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2012
MATH/B M I/BIOCHEM/BMOLCHEM 609 — MATHEMATICAL METHODS FOR SYSTEMS BIOLOGY
3 credits.

Provides a rigorous foundation for mathematical modeling of biological systems. Mathematical techniques include dynamical systems and differential equations. Applications to biological pathways, including understanding of bistability within chemical reaction systems, are emphasized. Enroll Info: None

Requisites: MATH 415 and (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

MATH 619 — ANALYSIS OF PARTIAL DIFFERENTIAL EQUATIONS
3 credits.

A rigorous introduction to the theoretical underpinnings of the basic methods and techniques in the modern theory of PDEs. It is aimed at math majors, but will also be useful to some students in the sciences, engineering and economics who feel the need for a deeper understanding of the theory of PDEs. The emphasis is on the exposure to a number of different methods of solution of PDEs and their connection to physical phenomena modeled by the equations. The goals include both learning to solve some basic types of PDEs as well as to understand the motivation behind and inner workings of the techniques involved. Enroll Info: None

Requisites: (MATH 322, 421, or 521) and (MATH 319, 320, 376, 415, or 519) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 621 — ANALYSIS III
3 credits.


Requisites: MATH 522 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2012

MATH 623 — COMPLEX ANALYSIS
3 credits.

Elementary functions of a complex variable; conformal mapping; complex integrals; the calculus of residues. Enroll Info: None

Requisites: MATH 521 or 521 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 627 — INTRODUCTION TO FOURIER ANALYSIS
3 credits.

Fourier series and integrals, and their applications. Enroll Info: None

Requisites: MATH 521 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2016

MATH 629 — INTRODUCTION TO MEASURE AND INTEGRATION
3 credits.

Lebesgue integral and measure, abstract measure and integration, differentiation, spaces of integrable functions. Enroll Info: None

Requisites: MATH 522 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/I SY E/OTM/STAT 632 — INTRODUCTION TO STOCHASTIC PROCESSES
3 credits.

Topics include discrete-time Markov chains, Poisson point processes, continuous-time Markov chains, and renewal processes. Applications to queueing, branching, and other models in science, engineering and business. Enroll Info: None

Requisites: (STAT/MATH 431, 309, STAT 311 or MATH 531) and (MATH 320, 340, 341, 375, 421 or 531) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019
MATH/IE/OTM 633 — QUEUING THEORY AND STOCHASTIC MODELING
3 credits.

Reliability theory; coherent systems and reliability bounds. Markovian queues and Jackson networks. Steady-state behavior of general service time queues. Priority queues. Approximation methods and algorithms for complex queues. Simulation. Dynamic programming; applications to inventory and queueing. Enroll Info: None
Requisites: STAT/IE/MATH/OTM 632
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2010

MATH 635 — AN INTRODUCTION TO BROWNIAN MOTION AND STOCHASTIC CALCULUS
3 credits.

Presents an introduction to Brownian motion and its application to stochastic calculus. Sample path properties of Brownian motion, Ito stochastic integrals, Ito’s formula, stochastic differential equations and properties of their solutions, and various applications will be included. Enroll Info: None
Requisites: (MATH 521 and STAT/IE/MATH/OTM 632) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2002

MATH/ECE 641 — INTRODUCTION TO ERROR-CORRECTING CODES
3 credits.

Coding theory. Codes (linear, Hamming, Golay, dual); decoding-encoding; Shannon’s theorem; sphere-packing; singleton and Gilbert-Varshamov bounds; weight enumerators; MacWilliams identities; finite fields; other codes (Reed-Muller, cyclic, BCH, Reed-Solomon) and error-correction algorithms. Enroll Info: None
Requisites: MATH 541 or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

MATH 681 — SENIOR HONORS THESIS
3 credits.

Individual study for honors math majors writing a thesis in mathematics. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Honors Only Courses (H)
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 682 — SENIOR HONORS THESIS
3 credits.

Individual study for honors math majors writing a thesis in mathematics. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Honors Only Courses (H)
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 691 — UNDERGRADUATE THESIS
2-4 credits.

Individual study for students writing a thesis in mathematics. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2018

MATH 692 — UNDERGRADUATE THESIS
2-4 credits.

Individual study for students writing a thesis in mathematics. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2002

MATH 698 — DIRECTED STUDY
1-3 credits.

Directed study projects as arranged with a faculty member. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018

MATH 699 — DIRECTED STUDY
1-6 credits.

Directed study projects as arranged with a faculty member. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019
Mathematics (MATH)

MATH 703 — METHODS OF APPLIED MATHEMATICS 1
3 credits.

Study of the linear algebraic structure underlying discrete equilibrium problems. Boundary value problems for continuous equilibria: Sturm-Liouville equations, Laplace’s equation, Poisson’s equation, and the equations for Stokes flow. Contour integration and conformal mapping. Applications of dynamics leading to initial value problems for ODEs and PDEs. Green’s functions for ODEs and introduction to asymptotic methods for ODEs, e.g. WKB analysis. Separation of variables and eigenfunction expansions for linear PDEs. Examples from physics and engineering throughout. Enroll Info: Knowledge of undergraduate linear algebra, analysis and complex analysis is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 704 — METHODS OF APPLIED MATHEMATICS-2
3 credits.


Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 705 — MATHEMATICAL FLUID DYNAMICS
3 credits.


Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MATH 707 — THEORY OF ELASTICITY
3 credits.

Topics in the theory of elasticity. Contents vary. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2011

MATH/STAT 709 — MATHEMATICAL STATISTICS
4 credits.

Introduction to measure theoretic probability; derivation and transformation of probability distributions; generating functions and characteristic functions; conditional expectation, sufficiency, and unbiased estimation; methods of large sample theory including laws of large numbers and central limit theorems; order statistics. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH/STAT 710 — MATHEMATICAL STATISTICS
4 credits.

Estimation, efficiency, Neyman-Pearson theory of hypothesis testing, confidence regions, decision theory, analysis of variance, and distribution of quadratic forms. Enroll Info: None
Requisites: STAT/MATH 709
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH/COMP SCI 714 — METHODS OF COMPUTATIONAL MATHEMATICS I
3 credits.

Development of finite difference methods for hyperbolic, parabolic and elliptic partial differential equations. Analysis of accuracy and stability of difference schemes. Direct and iterative methods for solving linear systems. Introduction to finite volume methods. Applications from science and engineering. Enroll Info: Students are strongly encouraged to have programming skills (e.g. COMP SCI 200) and some undergraduate numerical analysis (e.g. MATH/COMP SCI 514 or COMP SCI 412), analysis and differential equations (e.g. MATH 322 and MATH 521) and linear algebra (e.g. MATH 341).

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018
MATH/COMP SCI 715 — METHODS OF COMPUTATIONAL MATHEMATICS II
3 credits.

Introduction to spectral methods (Fourier, Chebyshev, Fast Fourier Transform), finite element methods (Galerkin methods, energy estimates and error analysis), and mesh-free methods (Monte-Carlo, smoothed-particle hydrodynamics) for solving partial differential equations. Applications from science and engineering. Applications from science and engineering. Enroll Info: Students are strongly encouraged to have programming skills (e.g. COMP SCI 200), undergraduate numerical analysis (e.g. MATH/COMP SCI 514 or COMP SCI 412), analysis (MATH 322 and math 521) and linear algebra (e.g. MATH 341 or equiv.)

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No
Last Taught: Spring 2019

MATH 716 — ORDINARY DIFFERENTIAL EQUATIONS
3 credits.

Existence, uniqueness, and continuous dependence theorems, linear systems, stability, singular points, and boundary value problems. Qualitative behavior of nonlinear equations, stability, Lyapunov functions, invariant manifolds, bifurcation theory, periodic orbits, and connecting orbits. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2012

MATH 721 — A FIRST COURSE IN REAL ANALYSIS
3 credits.

Real analysis concentrating on measures, integration, and differentiation and including an introduction to Hilbert spaces. Enroll Info: Knowledge of undergraduate analysis (e.g. the sequence MATH 521 and 522) is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No
Last Taught: Fall 2018

MATH 725 — A SECOND COURSE IN REAL ANALYSIS
3 credits.

Continuation of MATH 721. An introduction to further topics in real analysis: Banach spaces, Fourier transforms, elements of distribution theory, and applications. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No
Last Taught: Spring 2019

MATH/COMP SCI/I SY E/STAT 726 — NONLINEAR OPTIMIZATION I
3 credits.

Theory and algorithms for nonlinear optimization, focusing on unconstrained optimization. Line-search and trust-region methods; quasi-Newton methods; conjugate-gradient and limited-memory methods for large-scale problems; derivative-free optimization; algorithms for least-squares problems and nonlinear equations; gradient projection algorithms for bound-constrained problems; and simple penalty methods for nonlinearly constrained optimization. Enroll Info: Students are strongly encouraged to have knowledge of linear algebra and familiarity with basic mathematical analysis.

Requisites: Graduate/professional standing

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No
Last Taught: Fall 2018

MATH 727 — CALCULUS OF VARIATIONS AND RELATED TOPICS
3 credits.

Introduction to some classical methods in the calculus of variations and continues on to modern direct methods. Techniques for establishing and studying minima and other critical points will be developed. Applications will be chosen from a wide variety of fields: geometry, differential equations, classical mechanics, geodesics, and optimal control theory. Background material in the areas of application will be provided. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No
Last Taught: Fall 2009
### MATH/COMP SCI/I SY E 728 — INTEGER OPTIMIZATION
3 credits.

Introduces optimization problems over integers, and surveys the theory behind the algorithms used in state-of-the-art methods for solving such problems. Special attention is given to the polyhedral formulations of these problems, and to their algebraic and geometric properties. Applicability of Integer Optimization is highlighted with applications in combinatorial optimization. Key topics include: formulations, relaxations, polyhedral theory, cutting planes, decomposition, enumeration. Students are strongly encouraged to have knowledge of Linear Programming (e.g., MATH/COMP SCI/I SY E/STAT 525), including algorithms, duality and polyhedral theory. Enroll Info: None

**Requisites:** Graduate/professional standing

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

### MATH/COMP SCI/I SY E 730 — NONLINEAR OPTIMIZATION II
3 credits.

Theory and algorithms for nonlinearly constrained optimization. Relevant geometric concepts, including tangent and normal cones, theorems of the alternative, and separation results. Constraint qualifications. Geometric and algebraic expression of first-order optimality conditions. Second-order optimality conditions. Duality. Nonlinear programming algorithms: merit functions and filters; interior-point, augmented Lagrangian, and sequential quadratic programming algorithms. Enroll Info: None

**Requisites:** STAT/COMP SCI/I SY E/MATH 726

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Spring 2019

### MATH/STAT 734 — THEORY OF PROBABILITY II
3 credits.

Continuation of MATH/STAT 733. Possible topics include martingales, weak convergence of measures, introduction to Brownian motion. Enroll Info: None

**Requisites:** Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Spring 2019

### MATH 735 — STOCHASTIC ANALYSIS
3 credits.

Foundations of continuous time stochastic processes, semimartingales and the semimartingale integral, Ito's formula, stochastic differential equations, stochastic equations for Markov processes, application in finance, filtering, and control. Enroll Info: The course relies on measure theoretic probability theory that can be reviewed at the beginning of the semester.

**Requisites:** Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2018

### MATH 740 — ENUMERATIVE COMBINATORICS/SYMMETRIC FUNCTIONS
3 credits.

Inclusion-exclusion principle, permutation statistics, sieve methods, unimodal sequences, posets, lattice theory, Mobius functions, generating functions, bases and transition matrices for symmetric functions, Young tableaux, plane partitions, polytopes, poset homology, Stanley-Reisner rings. Enroll Info: None

**Requisites:** Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Spring 2017

### MATH 741 — ABSTRACT ALGEBRA
3 credits.

Usually a study of finite groups and noncommutative rings. Group theoretic topics may include: permutation groups, Lagrange's theorem, Cauchy's theorem and the Sylow theorems, solvable and nilpotent groups. Ring theoretic topics may include: Artinian rings and modules, the Wedderburn theorems, the Hopkins-Levitzki theorem, the Jacobson radical and density theorem. Enroll Info: The basic prerequisite for all advanced graduate courses in algebra. Familiarity with topics in undergraduate algebra (e.g. MATH 541 and 542) is strongly recommended.

**Requisites:** Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2018
MATH 742 — ABSTRACT ALGEBRA
3 credits.

Continuation of MATH 741. Usually the study of commutative rings and fields. Ring theoretic topics may include: modules over PIDs, Noetherian rings and the Hilbert basis theorem, the Lasker-Noether theorem, the Krull intersection theorem, integrality and the Hilbert Nullstellensatz. Field theoretic topics may include: algebraic extensions, Galois theory, solvability of polynomials and classical constructability problems. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 745 — THEORY OF GROUPS
3 credits.

Topics in finite group theory which may include: subnormality, coprime actions, the Schur-Zassenhaus theorem, solvable and nilpotent groups, transfer theory and its applications, and normal p-complement theorems. Occasionally, the focus may be on some aspects of infinite group theory. Enroll Info: Basic graduate algebra courses (e.g. MATH 741 and 742) are strongly recommended.
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2012

MATH 746 — TOPICS IN RING THEORY
3 credits.

Will alternate between commutative and noncommutative ring theory. Commutative topics include localization; local rings; dimension theory; Cohen-Macaulay rings. Noncommutative topics include projective modules; injective modules; flat modules; homological and global dimension; Wedderburn and Goldie rings. Enroll Info: Basic graduate algebra courses (e.g. MATH 741 and 742) are strongly recommended.
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2016

MATH 747 — LIE ALGEBRAS
3 credits.

Lie algebras and matrix groups. Topics: tangent spaces; exponentials; Baker-Campbell-Hausdorff formula; (nilpotent, solvable, semisimple) Lie algebras; Engel’s and Lie’s theorems; Levi decomposition; Killing form; sl(2)-representations; root systems; Dynkin diagrams; Weyl groups; Cartan and Borel subalgebras; Serre’s theorem. Enroll Info: Basic graduate algebra courses (e.g. MATH 541 and 542 or MATH 741 and 742) are strongly recommended.
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2014

MATH 748 — ALGEBRAIC NUMBER THEORY
3 credits.

A rigorous introduction to the arithmetic of number fields; algebraic integers, geometry of numbers, Dirichlet’s Unit Theorem, ideal class groups, first case of Fermat’s Last Theorem; prime decompositions, Galois automorphisms. Enroll Info: Basic graduate algebra courses (e.g. MATH 741 and 742) are strongly recommended.
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 749 — ANALYTIC NUMBER THEORY
3 credits.

An introduction to (abelian) Hecke L-functions and their arithmetic applications to topics such as the distribution of primes and the study of ideal class groups. Enroll Info: Basic graduate algebra courses (e.g. MATH 741 and 742) are strongly recommended
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MATH 750 — HOMOLOGICAL ALGEBRA
3 credits.

Topics include: complexes, cohomology, double complexes, spectral sequences; abelian categories, derived categories, derived functors; Tor and Ext, Koszul complexes; group cohomology; sheaf cohomology, hypercohomology. Enroll Info: Basic graduate algebra courses (e.g. MATH 741 and 742) are strongly recommended
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2018
MATH 751 — INTRODUCTORY TOPOLOGY I
3 credits.

An introduction to algebraic and differential topology. Elements of homotopy theory, fundamental group, covering spaces. Differentiable manifolds, tangent vectors, regular values, transversality, examples of compact Lie groups. Homological algebra, chain complexes, cell complexes, singular and cellular homology, calculations for surfaces, spheres, projective spaces, etc. Enroll Info: Familiarity with undergraduate algebra and topology MATH 541 or 551) is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 752 — INTRODUCTORY TOPOLOGY II
3 credits.

Continuation of MATH 751. Cohomology, Universal Coefficient Theorem, Kunneth Formula, cup and cap products, applications to manifolds, orientability, Poincare Duality. Differential forms, integration and Stokes Theorem, De Rham Theorem. Calculations, further duality theorems, Euler class, Lefschetz Fixed-Point Theorem. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 753 — ALGEBRAIC TOPOLOGY I
3 credits.

Higher homotopy groups, elements of obstruction theory, fibrations, bundle theory, classifying spaces, applications to smooth manifolds, differential forms, vector bundles, characteristic classes, cobordism, applications and calculations. Enroll Info: Basic graduate topology courses (e.g. MATH 751 and 752) are strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 754 — ALGEBRAIC TOPOLOGY II
3 credits.

Continuation of MATH 753. Topics include: spectral sequences and their applications, topology of Lie Groups, H-spaces, Hopf Algebras, homotopy classification of bundles, the Steenrod Algebra and its applications, introduction to generalized cohomology theories, spectra, elements of K-theory. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2013

MATH 751 — DIFFERENTIABLE MANIFOLDS
3 credits.

Differentiable manifolds, vector bundles, implicit function theorem, submersions and immersions, vector fields and flows, foliations and Frobenius theorem, differential forms and exterior calculus, integration and Stokes' theorem, De Rham theory, Riemannian metrics. Enroll Info: Familiarity with basic undergraduate analysis courses MATH 521 and 522 or MATH 621) is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2019

MATH 761 — INTRODUCTION TO ALGEBRAIC GEOMETRY
3 credits.

Algebraic preliminaries, including local rings; valuation theory, and power series rings; geometry of algebraic varieties with emphasis on curves and surfaces. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2018

MATH 762 — DIFFERENTIAL TOPOLOGY
3 credits.

Introduces the fundamental techniques and theorems of differential topology. The following topics will be covered: Submersions and immersions, Jet bundles, approximation, Sard's theorem, Whitney embedding theorem, transversality, intersection theory, Poincare-Hopf theorem, isotopy, Hopf-degree theorem, Corbodism, Morse theory, classification of two-manifolds. Enroll Info: Familiarity with the topics in a differentiable manifolds course (e.g. MATH 761) is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2010

MATH 763 — INTRODUCTION TO ALGEBRAIC GEOMETRY
3 credits.

Algebraic preliminaries, including local rings; valuation theory, and power series rings; geometry of algebraic varieties with emphasis on curves and surfaces. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019
MATH 765 — DIFFERENTIAL GEOMETRY
3 credits.

Covers the metric properties of Riemannian manifolds. The following topics will be covered: Vector bundles and connections, Riemannian metrics, submanifolds and second fundamental form, first variation of arc length, geodesics, Hopf-Rinow theorem, second variation of arc length, Jacobi fields and index lemmas, Bonnet-Meyer theorem, Rauch comparison theorem, spaces of constant curvature, Hodge-de Rham theory. Enroll Info: Familiarity with the topics in a differential manifolds course (e.g. MATH 761) is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2019

MATH 770 — FOUNDATIONS OF MATHEMATICS
3 credits.

First-order logic syntax and semantics, Completeness and Compactness Theorems, Lowenheim-Skolem Theorem, computable and computably enumerable sets, Incompleteness Theorem, axioms of Zermelo-Fraenkel set theory with choice, ordinal and cardinal arithmetic. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2018

MATH 771 — SET THEORY
3 credits.

Martin's Axiom, Suslin and Aronszajn trees, diamond principle, absoluteness and reflection, constructible universe, and one-step forcing constructions. Enroll Info: Familiarity with the topics in a basic Foundations course such as MATH 770 is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Fall 2018

MATH 773 — COMPUTABILITY THEORY
3 credits.

Turing degree and jump, strong reducibilities, arithmetic hierarchy, index sets, simple and (hyper)hypsersimple sets, easy forcing arguments in computability theory, finite and infinite injury, Friedberg-Muchnik and Sacks Splitting Theorem, Sacks Jump and Sacks Density Theorems, computable ordinals. Enroll Info: Familiarity with the topics in a basic Foundations course such as MATH 770 is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2019

MATH 776 — MODEL THEORY
3 credits.

Review of compactness and some consequences. Quantifier elimination with examples. The omitting types theorem. Categoricity. Baldwin-Lachlan theory. Strongly minimal and o-minimal theories. Saturated models. Morley's theorem. Enroll Info: Familiarity with the topics in a basic Foundations course such as MATH 770 is strongly recommended.

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Grad 50% - Counts toward 50% graduate coursework requirement

Last Taught: Spring 2019

MATH/CBE/E C E 777 — NONLINEAR DYNAMICS, BIFURCATIONS AND CHAOS
3 credits.

Advanced interdisciplinary introduction to qualitative and geometric methods for dissipative nonlinear dynamical systems. Local bifurcations of ordinary differential equations and maps. Chaotic attractors, horseshoes and detection of chaos. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Last Taught: Spring 2016

MATH 790 — MASTERS THESIS
1-3 credits.

Work on a Master's thesis under the supervision of a faculty member. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, for 2 number of completions

MATH 801 — TOPICS IN APPLIED MATHEMATICS
3 credits.

Selected topics in applied mathematics, applied analysis or numerical analysis and scientific computing. Enroll Info: None

Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program

Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: Yes, unlimited number of completions

Last Taught: Spring 2019
MATH/STAT 803 — EXPERIMENTAL DESIGN I
3 credits.
Summary of matrix algebra required, theory of estimable functions, incomplete blocks, balanced incomplete block designs, partially balanced incomplete block designs. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

MATH 805 — SPECIAL FUNCTIONS
3 credits.
Special functions arising from mathematics, physics, and engineering, their series and integral representations, differential and other functional equations, generating functions, and orthogonality. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2010

MATH 807 — DYNAMICAL SYSTEMS
3 credits.
Treats the qualitative behavior of continuous and discrete dynamical systems, including Hamiltonian systems of differential equations. Typical topics include periodic and almost periodic solutions, the fixed point theorem of Poincare and Birkhoff, invariant curves and KAM theory, celestial mechanics, and chaotic behavior. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2018

MATH 812 — ADVANCED METHODS OF APPLIED MATHEMATICS
3 credits.
Differential equations; asymptotic methods in complex analysis; problems of matching; integral transforms; integral equations; introduction to spectral theory; calculus of variations; tensor analysis. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2013

MATH 819 — PARTIAL DIFFERENTIAL EQUATIONS
3 credits.
Classical theory of partial differential equations, together with an introduction to the modern theory based on functional analysis. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2018

MATH 820 — PARTIAL DIFFERENTIAL EQUATIONS
3 credits.
Initial value problems in PDE, beginning with linear parabolic and hyperbolic equations, and continuing with nonlinear initial value problems. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 821 — ADVANCED TOPICS IN REAL ANALYSIS
3 credits.
Topics in partial differential equations and real analysis. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2018

MATH 823 — ADVANCED TOPICS IN COMPLEX ANALYSIS
3 credits.
Several complex variables. Basic several complex variables or more special topics. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2018

MATH 825 — SELECTED TOPICS IN FUNCTIONAL ANALYSIS
3 credits.
Topics will vary and may include spectral theory, nonlinear functional analysis or abstract harmonic analysis. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019
MATH 826 — ADVANCED TOPICS IN FUNCTIONAL ANALYSIS AND DIFFERENTIAL EQUATIONS
3 credits.
Topics in functional analysis and differential equations. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2016

MATH 827 — FOURIER ANALYSIS
3 credits.
Introduction to Fourier analysis in Euclidean spaces and related topics that may include singular and oscillatory integrals and trigonometric series. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

MATH 828 — ADVANCED TOPICS IN HARMONIC ANALYSIS
3 credits.
Continuation of MATH 827. Advanced topics in harmonic analysis. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2018

MATH/STAT 833 — TOPICS IN THE THEORY OF PROBABILITY
3 credits.
Advanced topics in probability and stochastic processes. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH/ECE 842 — TOPICS IN APPLIED ALGEBRA
3 credits.
Applied topics with emphasis on algebraic constructions and structures. Examples include: algebraic coding theory; codes (algebraic-geometric, convolutional, low-density-parity-check, space-time); curve and lattice based cryptography; watermarking; computer vision (face recognition, multiview geometry). Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

MATH 843 — REPRESENTATION THEORY
3 credits.
Introduction to the representation theory of Lie groups and their combinatorics. Universal enveloping algebras, highest weight modules, induction, restriction, weights, characters, multiplicity formulas, tensor products, Shapovalov forms, filtrations, Kazhdan-Light patterns, Littlewood paths. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2018

MATH 844 — ARITHMETIC GEOMETRY
3 credits.
An introduction to arithmetic geometry with emphasis on arithmetic of elliptic curves. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

MATH 845 — CLASS FIELD THEORY
3 credits.
Introduction to local and global class field theory. Theory of local fields; local and global class field theory; complex multiplication, adeles, ideles, idele class characters, Tchebotarev's Density Theorem, CM elliptic curves, construction of class fields of imaginary quadratic fields. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Details</th>
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<tbody>
<tr>
<td>MATH 846</td>
<td>TOPICS IN COMBINATORICS</td>
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<td>Topics in algebraic combinatorics such as</td>
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<td>(but not limited to) association schemes,</td>
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<td>hypergeometric series, classical orthogonal</td>
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<td>polynomials, codes, lattices, invariant theory,</td>
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<td>alternating sign matrices and domino tilings,</td>
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<td>statistical mechanical models, 6j-symbols,</td>
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<td>buildings and diagram geometries, matroids.</td>
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<td>MATH 847</td>
<td>TOPICS IN ALGEBRA</td>
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<td>Topics may include: Lie groups, algebraic</td>
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<td>groups, Chevalley groups, simple groups and</td>
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<td>associated geometries, group cohomology, group</td>
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<td>rings, Hopf algebras, enveloping algebras,</td>
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<td>quantum groups, infinite-dimensional Lie algebras,</td>
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<td>Hecke algebras, automorphic forms, Galois</td>
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<td>representations, zeta and L-functions, abelian</td>
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<td>varieties. Enroll Info: None</td>
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<td>Last Taught: Fall 2017</td>
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<td>MATH 848</td>
<td>ADVANCED TOPICS IN NUMBER THEORY</td>
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<td>This is an advanced graduate topic course in</td>
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<td>number theory. Topics will vary. Target</td>
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<td>audience: Advanced graduate students in number</td>
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<td>theory, representation theory, and algebraic</td>
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<td>geometry. Enroll Info: None</td>
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<td>MATH 849</td>
<td>AUTOMORPHIC FORMS</td>
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<td>Classical and/or modern theory of automorphic</td>
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<td>forms. Representation theory of GL(2). Enroll</td>
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<td>MATH 851</td>
<td>TOPICS IN GEOMETRIC TOPOLOGY</td>
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<td></td>
<td>Advanced Topics in Geometric Topology. Enroll</td>
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<td>MATH 853</td>
<td>TOPICS IN ALGEBRA TOPOLOGY</td>
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<td></td>
<td>Topics in Algebraic Topology. Enroll Info: None</td>
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<td>MATH 856</td>
<td>TOPICS IN DIFFERENTIAL TOPOLOGY</td>
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<td></td>
<td>The theory of differential manifolds such as</td>
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<td>differential forms and de Rham theorem,</td>
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<td>cobordism groups, Lie groups, homogeneous</td>
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<td>spaces, fiber bundles, characteristic classes.</td>
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<td>MATH 863</td>
<td>ADVANCED TOPICS IN ALGEBRAIC GEOMETRY</td>
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<td>Geometry of several complex variables; algebraic</td>
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<td>groups, abelian varieties; topological aspects</td>
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<td>of algebraic geometry, including sheaf theory</td>
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<td>and homology theory; advanced theory of local</td>
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<td>rings; intersection theory of algebraic</td>
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<td>varieties. Enroll Info: None</td>
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<td>MATH 865</td>
<td>ADVANCED TOPICS IN GEOMETRY</td>
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<td>Selected from advanced projective geometry,</td>
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<td>non-Euclidean geometry, Riemannian geometry,</td>
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<td>distance geometry and the geometry of convex</td>
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<td>surfaces, geometry of numbers. Enroll Info:</td>
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<td>Last Taught: Spring 2017</td>
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MATH 867 — ANALYTIC NUMBER THEORY
3 credits.
Prime number theory, prime number theory for arithmetic progressions, additive number theory, density theorems. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2015

MATH 873 — ADVANCED TOPICS IN FOUNDATIONS
3 credits.
Advanced topics from all areas of mathematical logic. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 903 — SEMINAR IN MATHEMATICS EDUCATION
1-3 credits.
Selected topics in Math Education. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2010

MATH 921 — SEMINAR IN ANALYSIS
1-3 credits.
Selected topics in Analysis. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 941 — SEMINAR-ALGEBRA
1-3 credits.
Selected topics in Algebra. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 951 — SEMINAR IN TOPOLOGY
1-3 credits.
Selected topics in Topology. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 967 — SEMINAR IN NUMBER THEORY
1-3 credits.
Selected topics in Number Theory. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 975 — SEMINAR-THE FOUNDATIONS OF MATHEMATICS
1-3 credits.
Selected topics in Mathematical Logic. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2015

MATH 990 — READING AND RESEARCH
1-3 credits.
Reading and research in all areas of Mathematics. Enroll Info: None
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2019

MATH 991 — SEMINAR IN APPLIED MATHEMATICS
1-3 credits.
Selected topics in Applied Mathematics. Enroll Info: None
Requisites: Graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2009