MATHEMATICS (MATH)

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.
Requisites: Placement into MATH 96
Repeatable for Credit: No
Last Taught: Spring 2024

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.
Requisites: MATH 96 or placement into MATH 112. 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 2024

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.
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 2024

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. 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
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

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.
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 2023

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. 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 2024

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.
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 2023

MATH 198 — DIRECTED STUDY
1-3 credits.

Directed study projects as arranged with a faculty member.
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. 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. 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 2024

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.
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 2024

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. 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 2024

MATH 221 — CALCULUS AND ANALYTIC GEOMETRY 1
5 credits.

Introduction to differential and integral calculus and plane analytic geometry; applications; transcendental functions.
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 2024

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.
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 2024

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. 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 2024

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.
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 2024

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.
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 2024

MATH 298 – DIRECTED STUDY IN MATHEMATICS
1-3 credits.

Directed study projects as arranged with a faculty member.
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 2023

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.
Requisites: MATH 234, 376, 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 2024

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.
Requisites: (STAT/MATH 309, STAT 311, STAT/MATH 431, or MATH 531) and (STAT 240, 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 2024

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.
Requisites: MATH 222, 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 2024

MATH 320 – LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS
3 credits.

An introduction to linear algebra and differential equations with emphasis on the relationship between the theory of linear algebra and analytical and numerical techniques for solving differential equations. Linear algebra topics include linear systems, matrices and their algebra, vector spaces and linear transformations, eigenvalues and eigenvectors. Topics from differential equations include first order ODE, homogeneous and nonhomogeneous linear systems, and numerical methods.
Requisites: MATH 222, 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 2024

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.
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 2024

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.
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 2024

MATH 331 – INTRODUCTORY PROBABILITY
3 credits.

Topics covered include axioms of probability, random variables, the most important discrete and continuous probability distributions, expectation and variance, conditional probability and conditional expectations, Markov's and Chebyshev's inequalities, laws of large numbers, and the central limit theorem. Includes a brief introduction to techniques of multivariate integration.
Requisites: MATH 213 or 222
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 2024

MATH 340 – ELEMENTARY MATRIX AND LINEAR ALGEBRA
3 credits.

An introduction to linear algebra. Topics include matrix algebra, linear systems of equations, vector spaces, sub-spaces, linear dependence, span, basis, rank of matrices, determinants, linear transformations, coordinate representations, kernel, range, eigenvalues and eigenvectors, diagonalization, inner products and orthogonal vectors, symmetric matrices. Covers linear algebra topics in greater depth and detail than MATH 320. Formal techniques in mathematical argument [MATH 341] not covered.
Requisites: MATH 222
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 2024

MATH 341 – LINEAR ALGEBRA
3 credits.

The theory of linear algebra with an introduction to proofs and proof writing. Topics include vector spaces, linear dependence, span, basis, linear transformations, kernel, image, inner products and inner product spaces, geometry, eigenvalues, eigenvectors, standard matrix factorizations. Other content includes basic set theory, logical operations, quantifiers, direct and indirect arguments, and induction. Differential equations [MATH 320] not covered.
Requisites: MATH 234
Course Designation: Breadth - Natural Science
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Accelerated Honors (!)
Repeatable for Credit: No
Last Taught: Spring 2024

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. 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 2023

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

Topics in multi-variable calculus and introduction to differential equations.
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 2024

MATH 390 – UNDERGRADUATE RESEARCH WITH MADISON EXPERIMENTAL MATHEMATICS LAB
3 credits.

An introduction to mathematical research. Instruction in ancillary skills such as literature review, mathematical software use, technical writing and communication, etc. Requires acceptance to the Madison Experimental Mathematics undergraduate research lab.
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: Fall 2023

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.
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.
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 2023

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.
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 2024

MATH/COMP SCI/I SY E 425 – INTRODUCTION TO COMBINATORIAL OPTIMIZATION
3 credits.

Focuses on optimization problems over discrete structures, such as shortest paths, spanning trees, flows, matchings, and the traveling salesman problem. We will investigate structural properties of these problems, and we will study both exact methods for their solution, and approximation algorithms.
Requisites: (MATH 320, 340, 341, or 375) or graduate/professional standing or member of the Pre-Masters Mathematics (Visiting International) Program
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2023

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.
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 2024

MATH/COMP SCI/E C E 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.
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 2024

MATH 441 – 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.
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 2016

MATH 443 – APPLIED LINEAR ALGEBRA
3 credits.

Review of matrix algebra. Simultaneous linear equations, linear dependence and rank, vector space, eigenvalues and eigenvectors, diagonalization, quadratic forms, inner product spaces, norms, canonical forms. Discussion of numerical aspects and applications in the sciences.
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: Fall 2023

MATH 444 – GRAPHS AND NETWORKS IN DATA SCIENCE
3 credits.

Mathematical foundations of networks with an emphasis on their applications in modern data science, using tools from algorithmic graph theory and linear algebra. Topics include: basics of graph theory, network statistics, graph traversal algorithms and implementation, matrix methods, community detection, PageRank, simulation of random graph models.
Requisites: (MATH 320, 340, 341, or 375) and (COMP SCI 200, 220, 300, 310, 320, or placement in COMP SCI 300), graduate/professional standing, or declared in Mathematics VISP (undergraduate or graduate)
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 2023

MATH 461 – COLLEGE GEOMETRY I
3 credits.

An introduction to Euclidean or non-Euclidean geometry.
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 2024

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.
Requisites: MATH 234, 375, (MATH 222 and COMP SCI/MATH 240), (MATH 222 and 320), or (MATH 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
Last Taught: Spring 2024

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

Capstone for future middle and high school teachers, drawing connections between higher mathematics and school mathematics.
Requisites: (MATH 341, 375, or 421) and (MATH 461 or concurrent enrollment)
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 2023

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

An historical survey of the main lines of mathematical development.
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 2024

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

Problems of enumeration, distribution, and arrangement. Inclusion-exclusion principle. Generating functions and linear recurrence relations. Combinatorial identities. Graph coloring problems. Finite designs. Systems of distinct representatives and matching problems in graphs. Potential applications in the social, biological, and physical sciences. Puzzles. Problem solving.
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 2024

MATH 490 – UNDERGRADUATE SEMINAR
1-3 credits.

Intermediate or upper level topics course in mathematics. Topics vary.
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 2023

MATH 491 – TOPICS IN UNDERGRADUATE MATHEMATICS
3 credits.

Intermediate or upper level topics course in mathematics. Topics vary.
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 2024

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

Direct and iterative solution of linear and nonlinear systems and of eigenproblems. LU and symmetric LU factorization. Complexity, stability, and conditioning. Nonlinear systems. Iterative methods for linear systems. QR-factorization and least squares. Eigenproblems: local and global methods.
Requisites: (MATH 340, 341, or 375) and (COMP SCI 200, 300, 301, 302, 310, or placement into COMP SCI 300) 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 2024

MATH/COMP SCI 514 — NUMERICAL ANALYSIS
3 credits.

Polynomial forms, divided differences. Polynomial interpolation. Polynomial approximation: uniform approximation and Chebyshev polynomials, least-squares approximation and orthogonal polynomials. Numerical differentiation and integration. Splines, B-splines and spline approximation. Numerical methods for solving initial and boundary value problems for ordinary differential equations.
Requisites: (MATH 320, 340, 341, or 375), (MATH 322, 376, 421, or 521), and (COMP SCI 200, 220, 300, 310, or 301 prior to Spring 2020, or placement into COMP SCI 300); grad/professional standing; 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 2024

MATH 519 — ORDINARY DIFFERENTIAL EQUATIONS
3 credits.

Provides a rigorous introduction to ordinary differential equations and dynamical systems. 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 2024

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.
Requisites: (MATH 234 and 467), (MATH 322, 341, 376, or 421), 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 2024

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.
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 2024

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

Introduces optimization problems whose constraints are expressed by linear inequalities. Develops geometric and algebraic insights into the structure of the problem, with an emphasis on formal proofs. Presents the theory behind the simplex method, the main algorithm used to solve linear optimization problems. Explores duality theory and theorems of the alternatives.
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 2024

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).
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 2024

MATH 535 – MATHEMATICAL METHODS IN DATA SCIENCE
3 credits.

A rigorous introduction to mathematical concepts important for modern data science. Topics include: matrix factorizations, optimization theory and algorithms, probabilistic models, finite Markov chains. Mathematical techniques are motivated by and illustrated on a range of applied problems from machine learning and statistics.
Requisites: (MATH 320, 340, 341, 375 or M E/COMP SCI/E C E 532) and (STAT/MATH 309, 431, MATH 531, STAT 311 or E C E 331) and (MATH 322, 341, 375, 421, 467, or COMP SCI 577), graduate/professional standing, or member of Pre-Masters Mathematics (Visiting Intl) Prgrm
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 2024

MATH 540 – LINEAR ALGEBRA II
3 credits.

Review of linear transformations, duality. Diagonalization of linear transformations.The Cayley Hamilton Theorem. Minimal polynomials. The Jordan canonical form. Exponential function. Inner product spaces, orthonormal bases and Gram-Schmidt orthogonalization. Operators on inner product spaces. Self-adjoint, unitary and positive operators. Spectral theorem. singular value decomposition. Bilinear and quadratic forms. Norms, bounded linear operators, matrix norms. Basic multilinear algebra. This is a second course in linear algebra.
Requisites: (MATH 234 or 375), (MATH 320, 340, 341, or 375), and (MATH 341, 375, 421, 467, 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 2024

MATH 541 – MODERN ALGEBRA
3 credits.

Groups, normal subgroups, Cayley's theorem, rings, ideals, homomorphisms, polynomial rings, abstract vector spaces.
Requisites: (MATH 234 or 375), (MATH 320, 340, 341, or 375), and (MATH 341, 375, 421, 467, 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 2024

MATH 542 – MODERN ALGEBRA
3 credits.

Field extensions, roots of polynomials, splitting fields, simple extensions, linear transformations, matrices, characteristic roots, canonical forms, determinants.
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 2024

MATH 551 – ELEMENTARY TOPOLOGY
3 credits.

Topological spaces, connectedness, compactness, separation axioms, metric spaces.
Requisites: (MATH 234 or 375), (MATH 320, 340, 341, or 375), and (MATH 341, 375, 421, 467, 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 2024

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.
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 2024

MATH 561 – DIFFERENTIAL GEOMETRY
3 credits.

Theory of curves and surfaces by differential methods.
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 2024

MATH 567 – MODERN NUMBER THEORY
3 credits.

A course in number theory covering fundamentals and modern applications in topics of recent interest: Modular arithmetic, quadratic reciprocity, arithmetic functions, zeta function, Diophantine equations, transcendental numbers, Roth's theorem, continued fractions, and the circle method. Optional material from probability including random matrix theory.
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
Honors - Honors Optional (%)
Repeatable for Credit: No
Last Taught: Spring 2024

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.
Requisites: (MATH 234 and 467) or (MATH 341, 375, 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 2022

MATH/PHILOS 571 – MATHEMATICAL LOGIC
3 credits.

Basics of logic and mathematical proofs; propositional logic; first order logic; undecidability.
Requisites: (MATH 234 or 375), (MATH 320, 340, 341, or 375), and (MATH 341, 375, 421, 467, 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 2021

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.
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 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. 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/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.
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: Fall 2023

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.
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 2024

MATH 621 – INTRODUCTION TO MANIFOLDS
3 credits.

Integration in Euclidean spaces, change of variables, multilinear algebra, vector fields and differential forms, manifolds and tangent spaces, integration on manifolds, Stokes theorem. Classical vector analysis. Cauchy integral theorem.
Requisites: MATH 522, (MATH 521 and 561), graduate/professional standing, or declared in Mathematics VISP
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 2023

MATH 623 – COMPLEX ANALYSIS
3 credits.

Elementary functions of a complex variable; conformal mapping; complex integrals; the calculus of residues.
Requisites: MATH 321 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 2023

MATH 627 – INTRODUCTION TO FOURIER ANALYSIS
3 credits.

Fourier series and integrals, and their applications.
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: Fall 2023

MATH 629 – INTRODUCTION TO MEASURE AND INTEGRATION
3 credits.

Lebesgue integral and measure, abstract measure and integration, differentiation, spaces of integrable functions.
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 2024

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.
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 2024

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.
Requisites: (MATH 521 and STAT/I SY E/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: Spring 2024

MATH/E C E 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.
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: Fall 2017

MATH 681 – SENIOR HONORS THESIS
3 credits.

Individual study for honors math majors writing a thesis in mathematics.
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 2023

MATH 682 – SENIOR HONORS THESIS
3 credits.

Individual study for honors math majors writing a thesis in mathematics.
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: Fall 2023

MATH 691 – UNDERGRADUATE THESIS
2-4 credits.

Individual study for students writing a thesis in mathematics.
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 692 – UNDERGRADUATE THESIS
2-4 credits.

Individual study for students writing a thesis in mathematics.
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 698 – DIRECTED STUDY
1-3 credits.

Directed study projects as arranged with a faculty member.
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 2024

MATH 699 – DIRECTED STUDY
1-6 credits.

Directed study projects as arranged with a faculty member.
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 2024

MATH 703 – METHODS OF APPLIED MATHEMATICS 1
3 credits.

Study of the linear algebraic structure underlying discrete equilibrium problems. Boundary value problems for continous 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. 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 2023

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

Derivation, nature and solution of canonical partial differential equations of applied mathematics. Conservation laws, advection, diffusion. First order PDEs, characteristics, shocks. Traffic flow, eikonal and Hamilton-Jacobi equations. Higher order PDEs: classification, Fourier analysis, well-posedness. Series solutions and integral transforms. Green's functions and distributions. Similarity solutions. Asymptotics of Fourier integrals. Laplace's method, stationary phase. Ship waves. Perturbation methods. 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: Spring 2024

MATH 705 – MATHEMATICAL FLUID DYNAMICS
3 credits.

Advanced introduction to fluid dynamics. Basic concepts; elementary viscous flow; Navier-Stokes equations. Elementary airfoil theory; boundary layers. Vortex motion. Waves. Very viscous flow. Compressible flows. Instabilities, bifurcations, turbulence. Requires working knowledge of multivariate calculus, differential equations and mechanics.
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 2024

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.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023

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.
Requisites: STAT/MATH 709
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

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. 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 2023

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. 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 2024

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.
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 2021

MATH 717 – STOCHASTIC COMPUTATIONAL METHODS
3 credits.

Introduction to computational methods that use stochastic algorithms and/or methods that are applied to random or stochastic mathematical problems. The main emphasis will be placed on learning practical tools, while some aspects of theoretical foundations will also be covered (e.g., basic error analysis for numerical solution of stochastic differential equations (SDEs), and basic convergence of Monte Carlo methods). Topics include Monte Carlo methods, Bayesian inference and Bayesian sampling, simulation of Markov chains, numerical analysis for SDEs, data assimilation / state estimation, stochastic optimization methods and random sketching. Applications to science, engineering, finance, data science, and other practical problems also included.
Requisites: Graduate/professional standing or declared in Mathematics Visiting International Student Program (graduate or dissertator)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

MATH 718 – RANDOMIZED LINEAR ALGEBRA AND APPLICATIONS
3 credits.

Random solvers have been playing increasingly crucial roles in the modern computational tasks. The recent breakthroughs in applied and computational linear algebra that incorporate techniques of randomization have proven to be of great importance in modern applied math, computational sciences and data science, such as inverse problems, machine learning and scientific computing. The guiding principle is that one may greatly reduce computational and storage expenses at the cost of a small probability of failure. Systematic study of these modern methods of randomized linear algebra solvers will be provided, presenting mathematical backgrounds, algorithms, and concrete applications. Core theoretical topics include randomized Kaczmarz and its generalization to stochastic gradient descent, randomized singular value decomposition, random sketching, matrix completion, and compressive sensing, and corresponding applications.
Requisites: Graduate/professional standing or declared in Mathematics VISP (graduate or dissertator)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No

MATH 719 – PARTIAL DIFFERENTIAL EQUATIONS
3 credits.

Classical theory of partial differential equations, together with an introduction to the modern theory based on functional analysis. Familiarity with basic measure theory (e.g. MATH 629 or 721) or concurrent registration in MATH 721 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 2023

MATH 720 – PARTIAL DIFFERENTIAL EQUATIONS
3 credits.

Linear elliptic, parabolic and hyperbolic equations, continuing with calculus of variations and then nonlinear initial value problems.
Requisites: Graduate/professional standing or declared in Mathematics VISP (graduate or dissertator)
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

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. 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 2023

MATH 722 – COMPLEX ANALYSIS
3 credits.

The basic theory of functions of one complex variable including Cauchy formula, singularities and residues, meromorphic functions, conformal mappings, harmonic functions, approximation and the nonhomogeneous d-bar equation. Requires knowledge of undergraduate analysis (e.g. the sequence Math 521/522).
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 2024

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.
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 2024

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. 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: Spring 2024

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.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

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.
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: Fall 2022

MATH/STAT 733 – THEORY OF PROBABILITY I
3 credits.

An introduction to measure theoretic probability and stochastic processes.Topics include foundations, independence, zero-one laws, laws of large numbers, convergence in distribution, characteristic functions, central limit theorems, random walks, conditional expectations. Familiarity with basic measure theory (e.g. MATH 629 or 721) or concurrent registration in MATH 721 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: Fall 2023

MATH/STAT 734 – THEORY OF PROBABILITY II
3 credits.

Possible topics include martingales, weak convergence of measures, introduction to Brownian motion.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

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. 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 2022

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.
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 2020

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. 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 2023

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.
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 2024

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. 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 2023

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. 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: Spring 2024

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. 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 2022

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. 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 2023

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. 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 2023

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. 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 2023

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.
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 2024

MATH 753 – ALGEBRAIC TOPOLOGY I
3 credits.

Higher homotopy groups, elements of obstruction theory, fibrations, bundle theory, classifying spaces, applications to smooth mainfolds, differential forms, vector bundles, characteristic classes, cobordism, applications and calculations. 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: Fall 2023

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, intorduction to generalized cohomology theories, spectra, elements of K-theory.
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 758 – INTRODUCTION TO ERGODIC THEORY AND DYNAMICS
3 credits.

An introduction to ergodic theory and dynamics covering fundamental theorems of ergodic theory, classical examples of one and two dimensional dynamics as well as applications to study of group actions.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

MATH 761 – 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. 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 2024

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.
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 2023

MATH 764 – INTRODUCTION TO ALGEBRAIC GEOMETRY
3 credits.

Continuation of MATH 763.
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 2023

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. 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: Fall 2023

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.
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 2023

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. 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 2021

MATH 773 – COMPUTABILITY THEORY
3 credits.

Turing degree and jump, strong reducibilities, arithmetic hierarchy, index sets, simple and (hyper)hypersimple 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. 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 2024

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. 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 2022

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.
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.
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
Last Taught: Spring 2024

MATH 801 – TOPICS IN APPLIED MATHEMATICS
3 credits.

Selected topics in applied mathematics, applied analysis or numerical analysis and scientific computing.
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 2023

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.
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 2020

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.
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 2023

MATH 821 – ADVANCED TOPICS IN REAL ANALYSIS
3 credits.

Topics in partial differential equations and real analysis.
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 2023

MATH 823 – ADVANCED TOPICS IN COMPLEX ANALYSIS
3 credits.

Several complex variables. Basic several complex variables or more special topics.
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 2023

MATH 825 – SELECTED TOPICS IN FUNCTIONAL ANALYSIS
3 credits.

Topics will vary and may include spectral theory, nonlinear functional analysis or abstract harmonic analysis.
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 2021

MATH 826 – ADVANCED TOPICS IN FUNCTIONAL ANALYSIS AND DIFFERENTIAL EQUATIONS
3 credits.

Topics in functional analysis and differential equations.
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.
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 2023

MATH 828 – ADVANCED TOPICS IN HARMONIC ANALYSIS
3 credits.

Continuation of MATH 827. Advanced topics in harmonic analysis.
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 2024

MATH/STAT 833 – TOPICS IN THE THEORY OF PROBABILITY
3 credits.

Advanced topics in probability and stochastic processes.
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 2023

MATH/E C E 842 – TOPICS IN APPLIED ALGEBRA
3 credits.

Applied topics with emhasis 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).
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 2024

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-Zetlin patterns, Littelmann paths.
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 2023

MATH 844 – ARITHMETIC GEOMETRY
3 credits.

An introduction to arithmetic geometry with emphasis on arithmetic of elliptic curves.
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 2022

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.
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 2024

MATH 846 – TOPICS IN COMBINATORICS
3 credits.

Topics in algebraic combinatorics such as (but not limited to) association schemes, hypergeometric series, classical orthogonal polynomials, codes, lattices, invariant theory, alternating sign matrices and domino tilings, statistical mechanical models, 6j-symbols, buildings and diagram geometries, matroids.
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 2023

MATH 847 – TOPICS IN ALGEBRA
3 credits.

Topics may include: Lie groups, algebraic groups, Chevalley groups, simple groups and associated geometries, group cohomology, group rings, Hopf algebras, enveloping algebras, quantum groups, infinite-dimensional Lie algebras, Hecke algebras, automorphic forms, Galois representations, zeta and L-functions, abelian varieties.
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 2022

MATH 848 – ADVANCED TOPICS IN NUMBER THEORY
3 credits.

This is an advanced graduate topic course in number theory. Topics will vary. Target audience: Advanced graduate students in number theory, representation theory, and algebraic geometry.
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 2021

MATH 849 – AUTOMORPHIC FORMS
3 credits.

Classical and/or modern theory of automorphic forms. Representation theory of GL(2).
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 2022

MATH 851 – TOPICS IN GEOMETRIC TOPOLOGY
3 credits.

Advanced Topics in Geometric Topology.
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 2023

MATH 853 – TOPICS IN ALGEBRAIC TOPOLOGY
3 credits.

Topics in Algebraic Topology.
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 2022

MATH 856 – TOPICS IN DIFFERENTIAL TOPOLOGY
3 credits.

The theory of differential manifolds such as differential forms and de Rham theorem, cobordism groups, Lie groups, homogeneous spaces, fiber bundles, characteristic classes.
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 2021

MATH 863 – ADVANCED TOPICS IN ALGEBRAIC GEOMETRY
3 credits.

Geometry of several complex variables; algebraic groups, abelian varieties; topological aspects of algebraic geometry, including sheaf theory and homology theory; advanced theory of local rings; intersection theory of algebraic varieties.
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 2023

MATH 865 – ADVANCED TOPICS IN GEOMETRY
3 credits.

Selected from advanced projective geometry, non-Euclidean geometry, Riemannian geometry, distance geometry and the geometry of convex surfaces, geometry of numbers.
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 2022

MATH 867 – ANALYTIC NUMBER THEORY
3 credits.

Prime number theory, prime number theory for arithmetic progressions, additive number theory, density theorems.
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.
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 2024

MATH/E C E/STAT 888 – TOPICS IN MATHEMATICAL DATA SCIENCE
1-3 credits.

Advanced topics in the mathematical foundations of data science
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 2023

MATH 900 – GRADUATE TEACHING SEMINAR
1 credit.

Focuses on theory and practical skills relevant to teaching mathematics at the graduate or post-secondary level.
Requisites: Declared in Mathematics PhD
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2023

MATH 921 – SEMINAR IN ANALYSIS
1-3 credits.

Selected topics in Analysis.
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 2024

MATH 941 – SEMINAR-ALGEBRA
1-3 credits.

Selected topics in Algebra.
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 2024

MATH 951 – SEMINAR IN TOPOLOGY
1-3 credits.

Selected topics in Topology.
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 2024

MATH 967 – SEMINAR IN NUMBER THEORY
1-3 credits.

Selected topics in Number Theory.
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 2024

MATH 975 – SEMINAR-THE FOUNDATIONS OF MATHEMATICS
1-3 credits.

Selected topics in Mathematical Logic.
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 2024

MATH 990 – READING AND RESEARCH
1-3 credits.

Reading and research in all areas of Mathematics.
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 2024