



MATHEMATICS (MATH)

MATH 800P Number and Operation for K-3 Mathematics Specialists

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences

Description: Number and operations. Place value and its role in arithmetic operations. Development of fractions and number systems. Develop the habits of mind of a mathematical thinker and to develop a depth of understanding of number and operations sufficient to enable the teacher to be a disciplinary resource for other K-3 teachers.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 800T Mathematics as a Second Language

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences

Notes: MATH 800T is intended for mid-level mathematics teachers.

Description: Numbers and operations. Careful reasoning, problem solving, and communicating mathematics both orally and in writing. Connections with other areas of mathematics. Development of mathematical thinking habits.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 801P Geometry, Measurement, and Algebraic Thinking for K-3 Mathematics Specialists

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences.

Description: Polygons, polyhedra, rigid motions, symmetry, congruence, similarity, measurement in one, two and three dimensions, functions, mathematical expressions, solving equations, sequences. Develop the habits of mind of a mathematical thinker and to develop a depth of understanding of geometry, measurement and algebraic thinking to enable the teacher to be a disciplinary resource for other K-3 teachers.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 802P Number, Geometry and Algebraic Thinking II for K-3 Math Specialists

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences

Notes: MATH 802P will not count toward the MA or MS degree in mathematics or statistics.

Description: Number sense and operations in the context of rational numbers, geometry and algebra in grades 4-6 curriculum, and how the mathematical content in grades K-3 (e.g., Taylor-Cox, 2003) lays a foundation for abstract thinking beginning in grades 4 and beyond. Designed to develop a depth of understanding sufficient to enable the teacher to be a disciplinary resource to other K-3 teachers.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 802T Functions, Algebra, and Geometry for Middle Level Teachers

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences

Description: Variables and functions. Use of functions in problem solving. Theory of measurement, especially length, area, and volume. Geometric modeling in algebra. Graphs, inverse functions, linear and quadratic functions, the fundamental theorem of arithmetic, modular arithmetic, congruence and similarity. Ways these concepts develop across the middle level curriculum.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 803P Algebraic Thinking in the Elementary Classroom

Prerequisites: A valid elementary or early childhood teaching certificate.

Notes: Not open to MA or MS students in mathematics or statistics.

Description: Course explores the mathematics supporting algebraic thinking in elementary mathematics. Develops a deeper understanding of algebraic properties and greater flexibility in mathematical reasoning. Case studies, video segments, and student work samples will be examined. Complex mathematical problems will be worked with connections made between participants' thinking and that of their students.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 803T Computational Thinking for Teachers

Prerequisites: Elementary or secondary teachers certification, or by permission.

Notes: As an 800-level course with a "T" designation, this course is intended for middle-level teachers pursuing the MAT degree from the Mathematics Department, the MA degree in Mathematics Education (CEHS) or simply taking graduate courses to further their education.

Description: This project-based course develops an understanding of computational thinking through engagement in problem-solving in a variety of real-world settings (some of them rather surprising) in our modern society and developing confidence and resources for implementing computational thinking activities in classrooms.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 804P Problem Solving and Critical Thinking in the Elementary Classroom

Prerequisites: A valid elementary or early childhood teaching certificate.

Notes: Not open to MA or MS students in mathematics or statistics.

Description: Course uses problem-solving experiences to develop teachers' critical-thinking skills in order to build a strong foundation for teaching and communicating mathematical concepts. Provides a guided opportunity for the implementation of problem-solving instruction is aligned with the Mathematics Standards in both the primary (K-2) and intermediate (3-5) elementary classroom.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 804T Experimentation, Conjecture and Reasoning

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences

Notes: MATH 804T is intended for middle-level mathematics teachers.

Description: Problem solving, reasoning and proof, and communicating mathematics. Development of problem solving skills through the extensive resources of the American Mathematics Competitions. Concepts of logical reasoning in the context of geometry, number patterns, probability and statistics

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 805T Discrete Mathematics for Middle Level Teachers

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences.

Notes: MATH 805T is intended for mid-level mathematics teachers.

Description: Concepts of discrete mathematics, as opposed to continuous mathematics, which extend in directions beyond, but related to, topics covered in middle-level curricula. Problems which build upon middle-level mathematics experiences. Logic, mathematical reasoning, induction, recursion, combinatorics, matrices, and graph theory.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 806T Number Theory and Cryptology for Middle Level Teachers

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences

Notes: MATH 806T is intended for mid-level mathematics teachers.

Description: Basic number theory results and the RSA cryptography algorithm. Primes, properties of congruences, divisibility tests, linear Diophantine equations, linear congruences, the Chinese Remainder Theorem, Wilson's Theorem, Fermat's Little Theorem, Euler's Theorem, and Euler's phi-function. Mathematical reasoning and integers' connections to the middle school curriculum.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 807 Mathematics for High School Teaching I

Crosslisted with: MATH 407

Prerequisites: MATH 208/208H and MATH 309 or MATH 310.

Notes: Open only MATH majors with a declared Education option.

Description: Analysis of the connections between college mathematics and high school algebra and precalculus.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Offered: SPRING

MATH 807T Using Mathematics to Understand Our World

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences.

Notes: MATH 807T is intended for middle-level mathematics teachers.

Description: The mathematics underlying several socially-relevant questions from a variety of academic disciplines. Construct mathematical models of the problems and study them using concepts developed from algebra, linear and exponential functions, statistics and probability. Original documentation, such as government data, reports and research papers, in order to provide a sense of the role mathematics plays in society, both past and present.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 808 Mathematics for High School Teaching II

Crosslisted with: MATH 408

Prerequisites: MATH 412 and MATH 309 or MATH 310.

Notes: Open only MATH majors with a declared Education option.

Description: Analysis of the connections between college mathematics and high school algebra and geometry.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Offered: FALL

MATH 808T Concepts of Calculus for Middle Level Teachers

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences.

Notes: MATH 808T is intended for middle-level mathematics teachers.

Description: The processes of differentiation and integration, their applications and the relationship between the two processes. Rates of change, slopes of tangent lines, limits, derivatives, extrema, derivatives of products and quotients, anti-derivatives, areas, integrals, and the Fundamental Theorem of Calculus. Connections to concepts in the middle level curriculum.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 809T History of Mathematics for Teachers

Prerequisites: Elementary or secondary teacher certification, or by permission.

Notes: As an 800-level course with a "T" designation, this course is intended for teachers pursuing the MAT degree from the Mathematics Department, the MA degree in Mathematics Education (CEHS) or simply taking graduate courses to further their education.

Description: Study of mathematical topics that comprise the K-12 curriculum and the development of these topics over time.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

Offered: SUMMER

MATH 810T Algebra for Algebra Teachers

Prerequisites: Admission to the MAT or MScT program in mathematics or to a graduate program in the College of Education and Human Sciences.

Description: The integers. The Euclidean algorithm, the Fundamental Theorem of Arithmetics, and the integers mod n . Polynomials with coefficients in a field. The division algorithm, the Euclidean algorithm, the unique factorization theorem, and its applications. Polynomials whose coefficients are rational, real or complex. Polynomial interpolation. The habits of mind of a mathematical thinker. The conceptual underpinnings of school algebra.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 811T Functions for High School Teachers

Prerequisites: A valid secondary mathematics teaching certificate or by permission

Description: Course examines mathematics underlying pre-calculus material through problem solving. Connections to other topics in mathematics, including algebra, geometry and advanced mathematics are highlighted.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 812T Geometry for Geometry Teachers

Prerequisites: A valid secondary mathematics teaching certificate

Description: Course examines mathematics underlying high school geometry through problem solving. Topics include Spherical, Euclidean and Hyperbolic geometry, introduction to Neutral geometry, Platonic and Archimedean solids and projective geometry.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 814 Linear Algebra

Prerequisites: A grade of P, C, or better in MATH 107 or MATH 107H

Notes: Not open to MA or MS students in mathematics or statistics.

Description: Fundamental concepts of linear algebra, including properties of matrix arithmetic, systems of linear equations, vector spaces, inner products, determinants, eigenvalues and eigenvectors, and diagonalization.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: MATH 415, MATH 815; MATH 842

MATH 814T Linear Algebra for Teachers

Prerequisites: A valid secondary mathematics teaching certificate or by permission.

Description: Emphasis on connections between linear equations, linear transformations and the geometry of lines and planes. Applications to production planning, encryption methods, and analyzing data. Topics include methods of solving linear systems with an emphasis on solution behavior, along with behaviors exhibited by explicit linear transformations.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Graded

MATH 815 Theory of Linear Transformations

Crosslisted with: MATH 415

Prerequisites: MATH 314/814; and MATH 309, MATH 310, or MATH 325.

Description: Topics fundamental to the study of linear transformations on finite and infinite dimensional vector spaces over the real and complex number fields including: subspaces, direct sums, quotient spaces, dual spaces, matrix of a transformation, adjoint map, invariant subspaces, triangularization and diagonalization. Additional topics may include: Riesz Representation theorem, projections, normal operators, spectral theorem, polar decomposition, singular value decomposition, determinant as an n -linear functional, Cayley-Hamilton theorem, nilpotent operators, and Jordan canonical form.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 816T Math in the City for Teachers

Prerequisites: An undergraduate course in at least one of statistics, differential equations or matrix algebra; a valid secondary mathematics teaching certificate

Description: A modeling course run in collaboration with area businesses or organizations in which real world problems are studied. Course emphasizes how mathematics is used outside academia.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 817 Introduction to Modern Algebra I

Prerequisites: MATH 417

Description: Topics from elementary group theory and ring theory, including fundamental isomorphism theorems, ideals, quotient rings, domains. Euclidean or principal ideal rings, unique factorization, modules and vector spaces including direct sum decompositions, bases, and dual spaces.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: MATH 818

MATH 818 Introduction to Modern Algebra II

Prerequisites: MATH 817

Description: Topics from field theory including Galois theory and finite fields and from linear transformations including characteristic roots, matrices, canonical forms, trace and transpose, and determinants.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: MATH 901; MATH 902; MATH 905; MATH 915

MATH 823 Complex Analysis**Crosslisted with:** MATH 423**Prerequisites:** A grade of P, C, or better in MATH 208 or MATH 208H**Description:** Complex numbers, functions of complex variables, analytic functions, complex integration, Cauchy's integral formulas, Taylor and Laurent series, calculus of residues and contour integration, conformal mappings, harmonic functions. Applications of these concepts in engineering, physical sciences, and mathematics.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 824 Introduction to Partial Differential Equations****Crosslisted with:** MATH 424**Prerequisites:** A grade of P, C, or better in MATH 208/208H and MATH 221/221H.**Notes:** Not open to MA or MS students in mathematics or statistics.**Description:** Derivation of the heat, wave, and potential equations; separation of variables method of solution; solutions of boundary value problems by use of Fourier series, Fourier transforms, eigenfunction expansions with emphasis on the Bessel and Legendre functions; interpretations of solutions in various physical settings.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Prerequisite for:** MECH 812**MATH 825 Mathematical Analysis I****Prerequisites:** MATH 325**Description:** Real number system, topology of Euclidean space and metric spaces, continuous functions, derivatives and the mean value theorem, the Riemann and Riemann-Stieltjes integral, convergence, the uniformity concept, implicit functions, line and surface integrals.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Prerequisite for:** MATH 826**MATH 826 Mathematical Analysis II****Prerequisites:** MATH 825**Description:** Real number system, topology of Euclidean space and metric spaces, continuous functions, derivatives and the mean value theorem, the Riemann and Riemann-Stieltjes integral, convergence, the uniformity concept, implicit functions, line and surface integrals.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Prerequisite for:** MATH 921; MATH 924; MATH 925; MATH 926; MATH 941**MATH 828 Principles of Operations Research****Crosslisted with:** MATH 428**Prerequisites:** MATH 314 or MATH 314H; and RAIK 270H, STAT 380, or MECH 321.**Description:** Introduction to techniques and applications of operations research. Includes linear programming, queueing theory, decision analysis, network analysis, and simulation.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 830 Differential Equations I****Prerequisites:** MATH 325**Description:** Phase diagrams, bifurcation theory, linear systems, the matrix exponential function, Floquet theory, stability theory, existence (Poincare-Bendixson Theorem) and non-existence of periodic solutions for non-linear ordinary differential equations, self-adjoint equations, and Sturm-Liouville theory.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Prerequisite for:** MATH 831**MATH 831 Differential Equations II****Prerequisites:** MATH 830**Description:** Vector calculus, transport equations, Laplace's equation, the heat equation, the wave equation, maximum principles, mean-value formulae, finite speed of propagation, energy methods, solution representations.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 833 Nonlinear Optimization****Crosslisted with:** MATH 433**Prerequisites:** MATH 208/208H; MATH 314/314H; and MATH 309, MATH 310, or MATH 325.**Description:** Mathematical theory of unconstrained and constrained optimization for nonlinear multivariate functions, particularly iterative methods, such as quasi-Newton methods, least squares optimization, and convex programming. Computer implementation of these methods.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** SPRING**MATH 839 Mathematical Biology****Crosslisted with:** MATH 439**Prerequisites:** MATH 221/221H & MATH 314/314H.**Description:** Discrete and continuous models in ecology: population models, predation, food webs, the spread of infectious diseases, and life histories. Elementary biochemical reaction kinetics; random processes in nature. Use of software for computation and graphics.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option

MATH 840 Numerical Analysis I

Crosslisted with: CSCE 440, CSCE 840, MATH 440

Prerequisites: CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; MATH 107. Credit toward the degree may be earned in only one of the following: CSCE440/MATH 440 and MECH 480

Description: Principles of numerical computing and error analysis covering numerical error, root finding, systems of equations, interpolation, numerical differentiation and integration, and differential equations. Modeling real-world engineering problems on digital computers. Effects of floating point arithmetic.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: CSCE 942

Course and Laboratory Fee: \$20

MATH 842 Methods of Applied Mathematics I

Prerequisites: MATH 821 and 814, or their equivalents

Description: Interdependence between mathematics and the physical and applied sciences. Includes the calculus of variations, scaling and dimensional analysis, regular and singular perturbation methods.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 845 Number Theory

Crosslisted with: MATH 445

Prerequisites: MATH 310.

Description: Fundamentals of number theory, including congruences, primality tests, factoring methods. Diophantine equations, quadratic reciprocity, continued fractions, and elliptic curves.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 847 Numerical Methods for Applied Math

Crosslisted with: MATH 447

Prerequisites: MATH 208/208H, MATH 221/221H & MATH 314/314H

Description: Numerical methods for approximate solutions of applied mathematics problems. Topics typically considered include numerical solution of linear systems of equations, approximation of eigenvalues and eigenvectors, numerical solution of nonlinear systems of equations, and numerical solution of initial value problems for ordinary differential equations. Given time, mathematical applications in optimization, machine learning, or data science may be considered.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: CSCE 942

MATH 850 Discrete Mathematics I

Prerequisites: MATH 310 or 325

Description: Enumeration of standard combinatorial objects (subsets, partitions, permutations). Structure and existence theorems for graphs and sub-graphs. Selected classes of error-correcting codes. Extremal combinatorics of graphs, codes, finite sets and posets.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: MATH 852

MATH 852 Discrete Math II

Prerequisites: MATH 850

Description: Enumeration of standard combinatorial objects (subsets, partitions, permutations). Structure and existence theorems for graphs and sub-graphs. Selected classes of error-correcting codes. Extremal combinatorics of graphs, codes, finite sets and posets.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 856 Differential Topology

Prerequisites: MATH 471/871

Description: Introduction to a selection of topics in differentiable manifolds, smooth maps, vector fields and vector bundles, embeddings and immersions, differential forms, integration on manifolds, and applications.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 871 Topology I

Prerequisites: MATH 325 or MATH 417

Description: Topological spaces, continuous functions, product and quotient spaces, compactness and connectedness, homotopy, fundamental groups.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: MATH 856; MATH 872

MATH 872 Topology II

Prerequisites: MATH 871 and MATH 417

Description: Fundamental groups and the van Kampen theorem, covering spaces and the Galois correspondence, applications to groups, homology and the Mayer-Vietoris theorem.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Prerequisite for: MATH 974

MATH 887 Probability Theory**Crosslisted with:** MATH 487**Prerequisites:** MATH 314 or MATH 314H; and MATH 309, MATH 310, or MATH 325.**Description:** Probability, conditional probability, Bayes' theorem, independence, discrete and continuous random variables, density and distribution functions, multivariate distributions, probability and moment generating functions, the central limit theorem, convergence of sequences of random variables, random walks, Poisson processes and applications.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 889 Stochastic Processes****Crosslisted with:** MATH 489**Prerequisites:** MATH 314 or MATH 314H; and STAT 380 or RAIK 270H.**Description:** Markov chains, continuous-time Markov processes, the Poisson process, Brownian motion, introduction to stochastic calculus.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 893 Seminar in Mathematics****Crosslisted with:** MATH 493**Prerequisites:** Permission.**Description:** Topics in one or more branches of mathematics.**Credit Hours:** 1-4**Min credits per semester:** 1**Max credits per semester:** 4**Max credits per degree:** 8**Grading Option:** Grade Pass/No Pass Option**MATH 894 Independent Study in Mathematics****Prerequisites:** Permission.**Description:** Directed reading or research with a faculty member.**Credit Hours:** 1-4**Min credits per semester:** 1**Max credits per semester:** 4**Max credits per degree:** 4**Grading Option:** Grade Pass/No Pass Option**MATH 899 Masters Thesis****Prerequisites:** Admission to masters degree program and permission of major adviser**Credit Hours:** 1-10**Min credits per semester:** 1**Max credits per semester:** 10**Max credits per degree:** 99**Grading Option:** Grade Pass/No Pass Option**MATH 901 Algebra I****Prerequisites:** MATH 818 or permission**Description:** In-depth treatment of groups, rings, modules, algebraic field extensions, Galois theory, multilinear products, categories.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 902 Algebra II****Prerequisites:** MATH 818 or permission**Description:** In-depth treatment of groups, rings, modules, algebraic field extensions, Galois theory, multilinear products, categories.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 905 Commutative Algebra I****Prerequisites:** MATH 818**Description:** A first course in commutative algebra covering core topics in the field including noetherian rings, graded rings, localization, Nakayama's lemma, integral extensions, primary decomposition, Hilbert functions, and dimension theory.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** FALL**Prerequisite for:** MATH 906; MATH 953**MATH 906 Commutative Algebra II****Prerequisites:** MATH 905**Description:** Continuation of Math 905, covering topics such as regular sequences, system of parameters, the Koszul complex, depth, Cohen-Macaulay rings, regular rings, and Gorenstein rings.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** SPRING**MATH 911 Theory of Groups****Description:** Basic topics of infinite and finite group theory from among geometric, combinatorial, and algorithmic group theory, homology of groups, solvable and nilpotent groups and representation theory.**Credit Hours:** 3-6**Min credits per semester:** 3**Max credits per semester:** 6**Max credits per degree:** 18**Grading Option:** Grade Pass/No Pass Option**MATH 915 Homological Algebra****Prerequisites:** MATH 818**Description:** Category theory, complexes and homology, Hom and tensor products, projective, injective and flat modules, resolutions, derived functors, and applications.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** FALL**MATH 918 Topics in Algebra****Credit Hours:** 3-6**Min credits per semester:** 3**Max credits per semester:** 6**Max credits per degree:** 18**Grading Option:** Grade Pass/No Pass Option

MATH 921 Measure and Integration**Prerequisites:** MATH 826 or permission**Description:** Rigorous treatment of integration and measure theory. General measures and measurable functions. Lebesgue measure and Lebesgue integral. Approximation of functions. Lebesgue's Monotone and Dominated Convergence Theorems. Signed measures and total variation of measures. Radon-Nikodym Theorem. Lebesgue-Stieltjes measures and integrals. Product measures and Fubini's theorem.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** FALL**Prerequisite for:** MATH 928**MATH 923 Topics in Analysis****Credit Hours:** 3-6**Min credits per semester:** 3**Max credits per semester:** 6**Max credits per degree:** 18**Grading Option:** Grade Pass/No Pass Option**MATH 924 Theory of Analytic Functions I****Prerequisites:** MATH 826 or permission**Description:** Complex number field, elementary functions, analytic functions, conformal mapping, integration and calculus of residues, entire and meromorphic functions, higher transcendental functions, Riemann surfaces.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 925 Theory of Analytic Functions II****Prerequisites:** MATH 826 or permission**Description:** Complex number field, elementary functions, analytic functions, conformal mapping, integration and calculus of residues, entire and meromorphic functions, higher transcendental functions, Riemann surfaces.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**MATH 926 Spectral Theory****Prerequisites:** MATH 826**Description:** Geometry of Hilbert spaces, compact operators and applications, self-adjoint and normal bounded operators, unbounded operators, spectrum of an operator and its properties, continuous and Borel functional calculus, applications as time permits**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** FALL**MATH 928 Functional Analysis****Prerequisites:** MATH 921**Notes:** Knowledge of linear algebra (at the level of MATH 314) is also needed.**Description:** Normed and semi-normed vector spaces, Banach spaces, operators, duality, L^p spaces, the Hahn-Banach theorem, reflexivity, Open Mapping and Closed Graph theorems, Uniform Boundedness Principle and the Banach-Steinhaus theorem, general and locally convex topological vector spaces, the Separating Hyperplane Theorem, and the Banach-Alaoglu Theorem.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** SPRING**MATH 934 Topics in Differential Equations****Credit Hours:** 3-6**Min credits per semester:** 3**Max credits per semester:** 6**Max credits per degree:** 18**Grading Option:** Grade Pass/No Pass Option**MATH 939 Topics in Applied Mathematics****Credit Hours:** 3-6**Min credits per semester:** 3**Max credits per semester:** 6**Max credits per degree:** 18**Grading Option:** Grade Pass/No Pass Option**MATH 941 Partial Differential Equations****Prerequisites:** MATH 826**Description:** Theory of distributions, Fourier transform, fundamental solutions, Sobolev space theory, weak formulation and solution of elliptic boundary value problems, elliptic regularity, Galerkin methods and other techniques of nonlinear analysis.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** FALL**MATH 953 Algebraic Geometry****Prerequisites:** MATH 905**Description:** An introduction to algebraic geometry, including affine and projective varieties, coordinate rings, the Zariski topology, the Nullstellensatz, and dimensions of varieties.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Grade Pass/No Pass Option**Offered:** SPRING**MATH 958 Topics in Discrete Mathematics****Credit Hours:** 3-6**Min credits per semester:** 3**Max credits per semester:** 6**Max credits per degree:** 18**Grading Option:** Grade Pass/No Pass Option

MATH 974 Low Dimensional Topology

Prerequisites: MATH 872

Description: Foundational topics in low-dimensional topology: Surfaces and 3- and 4-manifolds, geometric structures on manifolds, classification and canonical decompositions, knot theory; applications.

Credit Hours: 3

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

Offered: FALL

MATH 990 Topics in Topology

Credit Hours: 3-6

Min credits per semester: 3

Max credits per semester: 6

Max credits per degree: 18

Grading Option: Grade Pass/No Pass Option

MATH 993 Seminar in Mathematics

Description: Advanced topics in one or more branches of mathematics.

Credit Hours: 1-3

Min credits per semester: 1

Max credits per semester: 3

Max credits per degree: 3

Grading Option: Grade Pass/No Pass Option

MATH 994 Independent Study in Mathematics

Prerequisites: Permission.

Description: Independent reading or research directed by a faculty member.

Credit Hours: 1-12

Min credits per semester: 1

Max credits per semester: 12

Max credits per degree: 24

Grading Option: Grade Pass/No Pass Option

MATH 995 Research Seminar

Credit Hours: 1-3

Min credits per semester: 1

Max credits per semester: 3

Max credits per degree: 6

Grading Option: Grade Pass/No Pass Option

MATH 999 Doctoral Dissertation

Prerequisites: Admission to doctoral degree program and permission of supervisory committee chair

Credit Hours: 1-24

Min credits per semester: 1

Max credits per semester: 24

Max credits per degree: 99

Grading Option: Grade Pass/No Pass Option