MATHEMATICS (MTH)

MTH 065, ELEMENTARY ALGEBRA, 3 Credits
Arithmetic of signed numbers, order of operations, simplifying algebraic expressions, solutions of linear equations, and inequalities. Rules of exponents, addition, subtraction, and multiplication of polynomials, factoring, solution of quadratic equations by factoring, reducing rational expressions. Word problems involving linear equations, graphing of linear equations, inequalities. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: Math Placement Test with a score of 05 or Math Placement - ALEKS with a score of 015
Available via Ecampus

MTH 095, INTERMEDIATE ALGEBRA, 3 Credits
Addition, subtraction, multiplication, and division of rational expressions, long division of polynomials, solutions of fractional equations, applications involving linear equations. Fractional equations, inequalities, literal equations, and variations. Negative and fractional exponents, radicals, solutions of quadratic equations, and complex numbers. Cartesian coordinates, graphs of linear equations and inequalities, distance formula, slope, equations of lines, solutions of systems of linear equations in two unknowns and inequalities. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 065 with C- or better or Math Placement Test with a score of 11 or Math Placement - ALEKS with a score of 030

MTH 102, ALGEBRAIC FOUNDATIONS, 3 Credits
This course is designed primarily for EOP students. They will use various computing technologies to explore realistic and interesting situations in which algebra is used. As they work through explorations, they will work with many of the fundamental ideas of algebra, ideas they will find important in their daily lives.

MTH 103, ALGEBRAIC REASONING, 4 Credits
Graphing data, functions, rate of change, linear equations, systems of linear equations, linear inequalities, linear functions, absolute value functions, quadratic functions, exponential functions. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 065 with C- or better or Math Placement Test with a score of 11 or Math Placement - ALEKS with a score of 030
Available via Ecampus

MTH 105, *INTRODUCTION TO CONTEMPORARY MATHEMATICS, 3 Credits
Elementary linear programming, combinatorics, descriptive statistics, elementary probability, exponential growth and decay, examples of major mathematical ideas and models. Lec/rec. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Recommended: MTH 095 or MTH 103 or (MPT=Math Placement Test score of 17; MPAL=Math Placement Test-ALEKS score of 46%)
Available via Ecampus

MTH 111, *COLLEGE ALGEBRA, 4 Credits
Polynomial equations and inequalities, polynomial functions and graphs, inverse functions, exponential and logarithmic functions, elementary mathematical modeling and applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with a C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 095 with C- or better or MTH 103 with C- or better or Math Placement Test with a score of 17 or Math Placement - ALEKS with a score of 046
Available via Ecampus

MTH 112, *ELEMENTARY FUNCTIONS, 4 Credits
Triangle trigonometry, circular functions and graphs, trigonometric equations and identities, inverse trigonometric functions, polar coordinates, vectors and applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Equivalent to: MTH 150X
Available via Ecampus

MTH 199, SPECIAL TOPICS, 1-16 Credits
Maximum 3 credits per term, 9 credits total. Does not meet university group requirement in physical science. This course is repeatable for 9 credits.

MTH 211, *FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits
Introduction to problem solving, sets, whole numbers, number theory, fractions. Intended primarily for prospective elementary teachers. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 095 with C- or better or MTH 103 with C- or better or MTH 111 with C- or better or MTH 112 with C- or better or Math Placement Test with a score of 17 or Math Placement - ALEKS with a score of 046

MTH 212, FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits
Math 212 is the second of a three-term sequence of courses designed to help prepare prospective elementary and middle school teachers. Topics covered include fractions, decimals, percent, ratio and proportion, integers, rational numbers, real numbers, probability and statistics.
Prerequisite: MTH 211 with C- or better
MTH 227, *CALCULUS AND PROBABILITY FOR THE LIFE SCIENCES I, 4 Credits
Review of exponential and trigonometric functions, including examples of exponential and periodic behavior; discrete probability; examples of biologically motivated difference equations; differentiation of polynomials, exponential and trigonometric functions with applications to optimization. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 112 with C- or better or MTH 150X with C- or better or Math Placement Test with a score of 33 or Math Placement - ALEKS with a score of 75
Equivalent to: MTH 227X

MTH 228, CALCULUS AND PROBABILITY FOR THE LIFE SCIENCES II, 4 Credits
Continuation of MTH 227 with more general population growth models. Antidifferentiation; The Fundamental Theorem of Calculus applied to solving continuous growth models. Continuous random variables. Basic linear algebra of small systems sufficient to calculate eigenvalues and eigenvectors and appreciate their use in life science applications. Lec/rec.
Prerequisite: MTH 227 with C- or better or MTH 227X with C- or better

MTH 231, ELEMENTS OF DISCRETE MATHEMATICS, 4 Credits
Elementary logic and set theory, functions, direct proof techniques, contradiction and contraposition, mathematical induction and recursion, elementary combinatorics, basic graph theory, minimal spanning trees. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 227 with C- or better or MTH 227X with C- or better

MTH 231H, ELEMENTS OF DISCRETE MATHEMATICS, 4 Credits
Elementary logic and set theory, functions, direct proof techniques, contradiction and contraposition, mathematical induction and recursion, elementary combinatorics, basic graph theory, minimal spanning trees. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Available via Ecampus

MTH 241, *CALCULUS FOR MANAGEMENT AND SOCIAL SCIENCE, 4 Credits
Elementary differential calculus of polynomial, logarithmic, and exponential functions and their applications to business, management and social sciences. Lec/rec. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Available via Ecampus

MTH 245, *MATHEMATICS FOR MANAGEMENT, LIFE, AND SOCIAL SCIENCES, 4 Credits
Techniques of counting, probability and elements of statistics including binomial and normal distributions. Introductory matrix algebra. Elements of linear programming. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 111 with C- or better or Math Placement Test with a score of 24 or Math Placement - ALEKS with a score of 060
Available via Ecampus

MTH 251, *DIFFERENTIAL CALCULUS, 4 Credits
Differential calculus for engineers and scientists. Rates of change: the derivative, velocity, and acceleration. The algebraic rules of differential calculus and derivatives of polynomial, rational, and trigonometric functions. Maximum-minimum problems, curve sketching, and other applications. Antiderivatives and simple motion problems. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with a C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math
Prerequisite: MTH 112 with C- or better or MTH 150X with C- or better or Math Placement Test with a score of 33 or Math Placement - ALEKS with a score of 075
Available via Ecampus

MTH 251H, *DIFFERENTIAL CALCULUS, 4 Credits
Differential calculus for engineers and scientists. Rates of change: the derivative, velocity, and acceleration. The algebraic rules of differential calculus and derivatives of polynomial, rational, and trigonometric functions. Maximum-minimum problems, curve sketching, and other applications. Antiderivatives and simple motion problems. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Bacc Core Course)
Attributes: CSMA – Core, Skills, Math; HNRS – Honors Course Designator
Prerequisite: MTH 112 with C- or better or MTH 150X with C- or better or Math Placement Test with a score of 33 or Math Placement - ALEKS with a score of 075
Equivalent to: MTH 251

MTH 252, INTEGRAL CALCULUS, 4 Credits
Definite integrals, elementary applications to area, force, and work. Integral tables and basic techniques of integration, calculus of logarithmic and exponential functions, polar coordinates, applications to areas, volumes, force, work, and growth and decay problems. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 251 with C- or better or MTH 251H with C- or better
Equivalent to: MTH 252H
Available via Ecampus
MTH 252H, INTEGRAL CALCULUS, 4 Credits
Definite integrals, elementary applications to area, force, and work. Integral tables and basic techniques of integration, calculus of logarithmic and exponential functions, polar coordinates, applications to areas, volumes, force, work, and growth and decay problems. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 251 with C- or better or MTH 251H with C- or better
Equivalent to: MTH 252

MTH 253, INFINITE SERIES AND SEQUENCES, 4 Credits
Indeterminate forms. Improper integrals. Sequences and series, especially Taylor's formula and power series. Applications to numerical estimation with error analysis. Series with complex terms and the Euler identities. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 253H

MTH 254, VECTOR CALCULUS I, 4 Credits
Vectors, vector functions, and curves in two and three dimensions. Surfaces, partial derivatives, gradients, and directional derivatives. Multiple integrals in rectangular, polar, cylindrical, and spherical coordinates. Physical and geometric applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 254H
Available via Ecampus

MTH 254H, VECTOR CALCULUS I, 4 Credits
Vectors, vector functions, and curves in two and three dimensions. Surfaces, partial derivatives, gradients, and directional derivatives. Multiple integrals in rectangular, polar, cylindrical, and spherical coordinates. Physical and geometric applications. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 254

MTH 255, VECTOR CALCULUS II, 4 Credits
Brief review of vector functions, space curves, gradients, and directional derivatives. Introduction to vector analysis: vector fields, divergence, curl, line integrals, surface integrals, conservative fields, and the theorems of Gauss and Stokes with applications to force, work, mass, and charge. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 255H

MTH 255H, VECTOR CALCULUS II, 4 Credits
Brief review of vector functions, space curves, gradients, and directional derivatives. Introduction to vector analysis: vector fields, divergence, curl, line integrals, surface integrals, conservative fields, and the theorems of Gauss and Stokes with applications to force, work, mass, and charge. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 255

MTH 256, APPLIED DIFFERENTIAL EQUATIONS, 4 Credits
First order linear and nonlinear equations, and second order linear equations. Applications to electric circuits and mechanical oscillators. Introduction to the Laplace transform and higher order equations. Solution methods and applications appropriate for science and engineering. (Familiarity with complex numbers and Euler's identities is highly desirable.) Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 256H
Available via Ecampus

MTH 256H, APPLIED DIFFERENTIAL EQUATIONS, 4 Credits
First order linear and nonlinear equations, and second order linear equations. Applications to electric circuits and mechanical oscillators. Introduction to the Laplace transform and higher order equations. Solution methods and applications appropriate for science and engineering. (Familiarity with complex numbers and Euler's identities is highly desirable.) All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better
Equivalent to: MTH 256

MTH 264, INTRODUCTION TO MATRIX ALGEBRA, 2 Credits
Introduction to matrix algebra: systematic solution to systems of linear equations; linear transformations; eigenvalue problems.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Available via Ecampus

MTH 264H, INTRODUCTION TO MATRIX ALGEBRA, 2 Credits
Introduction to matrix algebra: systematic solution to systems of linear equations; linear transformations; eigenvalue problems.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
MTH 265, INTRODUCTION TO SERIES, 2 Credits
Convergence and divergence of numerical series, including geometric series. Series of functions. Power series and their analytic properties. Taylor series expansions and Taylor polynomials.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Available via Ecampus

MTH 265H, INTRODUCTION TO SERIES, 2 Credits
Convergence and divergence of numerical series, including geometric series. Series of functions. Power series and their analytic properties. Taylor series expansions and Taylor polynomials.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 265

MTH 299, SPECIAL TOPICS, 0-16 Credits
Maximum 3 credits per term, 9 credits total.
This course is repeatable for 9 credits.

MTH 306, MATRIX AND POWER SERIES METHODS, 4 Credits
Introduction to matrix algebra, determinants, systematic solution to linear systems, and eigenvalue problems. Convergence and divergence of series with emphasis on power series, Taylor series expansions, convergence tests for power series, and error estimates for truncated series used in practical approximations. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 306H

MTH 306H, MATRIX AND POWER SERIES METHODS, 4 Credits
Introduction to matrix algebra, determinants, systematic solution to linear systems, and eigenvalue problems. Convergence and divergence of series with emphasis on power series, Taylor series expansions, convergence tests for power series, and error estimates for truncated series used in practical approximations. Lec/rec. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Attributes: HNRS – Honors Course Designator
Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better
Equivalent to: MTH 306

MTH 311, ADVANCED CALCULUS I, 4 Credits
Rigorous development of calculus, axiomatic properties of the real numbers, topology of the real line, convergence of sequences and series of real numbers, functions, limits of functions, basic properties of continuity and derivatives. Brief treatment of Riemann integration, improper integrals, sequences of functions, pointwise and uniform convergence, introductory aspects of multivariable calculus. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 254 with C- or better or MTH 254H with C- or better) and MTH 355 [C-]

MTH 312, ADVANCED CALCULUS II, 4 Credits
Rigorous development of calculus, axiomatic properties of , topology of the real line, convergence of sequences and series of real numbers, functions, limits of functions, basic properties of continuity and derivatives. Brief treatment of Riemann integration, improper integrals, sequences of functions, pointwise and uniform convergence, introductory aspects of multivariable calculus. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 311 with C- or better

MTH 321, INTRODUCTORY APPLICATIONS OF MATHEMATICAL SOFTWARE, 3 Credits
An introduction to select mathematical software packages to support problem solving and applications. Topics include using computational resources to solve basic numerical and symbolic problems in mathematics, visualization and presentation of data, creation of simple programming scripts, and applications of basic programming techniques to promote mathematical understanding. The scientific typesetting language LaTeX will also be covered. All courses used to satisfy MTH prerequisites must be completed with a C- or better.
Prerequisite: MTH 341 with C- or better or (MTH 264 with C- or better or MTH 264H with C- or better) or (MTH 306 with C- or better or MTH 306H with C- or better)

MTH 323, ^MATHEMATICAL MODELING, 3 Credits
A variety of mathematical modeling techniques will be introduced. Students will formulate models in response to practical problems drawn from the literature of ecology, environmental sciences, engineering or other fields. Informal writing assignments in class and formal written presentation of the models will be required. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 333, ^FUNDAMENTAL CONCEPTS OF TOPOLOGY, 3 Credits
Open and closed sets, continuity, compactness, connectedness, winding number, fixed point theorems in the plane. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: MTH 341 with C- or better or MTH 355 with C- or better

MTH 338, ^NON-EUCLIDEAN GEOMETRY, 3 Credits
Introduction to non-Euclidean geometries. Selected topics such as hyperbolic and elliptic geometry, spherical geometry, projective geometry, geometries arising from alternative metrics. All courses used to satisfy MTH prerequisites must be completed with C- or better. (Writing Intensive Course)
Attributes: CWIC – Core, Skills, WIC
Prerequisite: MTH 341 (may be taken concurrently) with C- or better
MTH 341, LINEAR ALGEBRA I, 3 Credits
Matrix algebra, determinants, systems of linear equations, subspaces, an introductory study of eigenvalues and eigenvectors. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 254 with C- or better or MTH 254H with C- or better

MTH 342, LINEAR ALGEBRA II, 4 Credits
Abstract (real or complex) vector spaces, linear transformations, inner product spaces, orthogonality, eigenspaces and diagonalization, spectral theorems, singular value decomposition. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better

MTH 343, INTRODUCTION TO MODERN ALGEBRA, 4 Credits
Introduction to algebraic abstraction, with an emphasis on structures and logical communication by way of proofs. Material includes an introduction to groups, rings and fields. Emphasis is on symmetry groups, the integers as a ring, and polynomial rings; selected applications. Generalizing from examples to mathematical statements, reading proofs, and both creating and editing proofs. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better and MTH 355 [C-]

MTH 351, INTRODUCTION TO NUMERICAL ANALYSIS, 3 Credits
Introduction to the computation of approximate solutions to mathematical problems that cannot be solved by hand: analysis of errors; rootfinding for nonlinear equations in one variable; interpolation of functions; numerical integration. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 253 with C- or better or (MTH 306 with C- or better or MTH 306H with C- or better) or (MTH 265 with C- or better or MTH 265H with C- or better) and (MTH 265 [C-] or MTH 265H [C-])
Recommended: Programming experience

MTH 355, DISCRETE MATHEMATICS, 3 Credits
Proof analysis and development in the context of discrete mathematics for math majors transitioning to upper-division course work. Topics include elementary logic and set theory, quantifiers, basic counting principles, elementary combinatorics, equivalence relations, the binomial theorem, and mathematical induction. Additional topics may include recurrence relations, generating functions, and introductory graph theory. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 253 with C- or better
Recommended: MTH 341

MTH 361, INTRODUCTION TO PROBABILITY, 3 Credits
Probability problem solving using concepts developed in calculus. Topics include probability models, discrete and continuous random variables, expectation and variance, the law of large numbers, and the central limit theorem. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 253 with C- or better or (MTH 306 with C- or better or MTH 306H with C- or better) or (MTH 265 with C- or better or MTH 265H with C- or better)
Equivalent to: MTH 361H

MTH 390, FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits
Math 390 is the third of a three-term sequence of classes designed to help prepare prospective elementary and middle school teachers. Topics covered include informal geometry, measurement, congruence, similarity, coordinate and transformational geometry.
Prerequisite: MTH 211 with C- or better and MTH 212 [C-]

MTH 399, SPECIAL TOPICS, 1-16 Credits
This course is repeatable for 16 credits.

MTH 399H, SPECIAL TOPICS, 1-16 Credits
Attributes: HNRS – Honors Course Designator
Equivalent to: MTH 399
This course is repeatable for 16 credits.

MTH 401, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MTH 403, THESIS, 1-16 Credits
This course is repeatable for 16 credits.

MTH 405, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

MTH 406, PROJECTS, 1-3 Credits
Graded P/N.
This course is repeatable for 16 credits.

MTH 407, SEMINAR, 3 Credits
This course is repeatable for 99 credits.

MTH 410, OCCUPATIONAL INTERNSHIP, 3-12 Credits
Planned and supervised training experience at selected government, industrial, or business placement sites. Must be followed by a one-hour post-internship seminar. Consult departmental head advisor. Graded P/N.
This course is repeatable for 16 credits.

MTH 411, REAL ANALYSIS, 3 Credits
Properties of metric spaces and normed spaces, including lp spaces. Completeness and applications, including fixed point theorems. Compactness. Equicontinuity and the Arzela-Ascoli theorem. Uniform continuity and uniform convergence, including applications.
Prerequisite: MTH 312 with B+ or better and MTH 341 [B+]
This course is repeatable for 18 credits.
MTH 428, STOCHASTIC ELEMENTS IN
MATHEMATICAL BIOLOGY, 3 Credits
An introduction to stochastic modeling of biological processes. The
stochastic models covered may include Markov processes in both
continuous and discrete time, urn models, branching processes, and
coalescent processes. The biological applications may include genetic
drift, population dynamics, genealogy, demography, and epidemiology.
Mathematical results will be qualitatively interpreted and applied to the
biological process under investigation.
Prerequisite: MTH 341 with C or better and (MTH 361 [C] or MTH 463 [C]
or MTH 563 [C])

MTH 430, METRIC SPACES AND
TOPOLOGY, 3 Credits
Fundamental notions of metric space topology. Examples of Euclidean,
non-Euclidean and other fundamental metric spaces including the Hilbert
Cube and two-dimensional surfaces. Characterization and classification
results for metric spaces. Selected applications of topology, possibly
including the structure of molecules and/or networks. All courses used to
satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 311 with C or better
Recommended: MTH 311

MTH 434, INTRODUCTION TO
DIFFERENTIAL GEOMETRY, 3 Credits
Curves and surfaces in Euclidean space; geodesics; curvature;
introduction to tensor algebra and differential forms; selected
applications. All courses used to satisfy MTH prerequisites must be
completed with C- or better.
Prerequisite: (MTH 255 with C- or better or MTH 255H with C- or better)
and MTH 342 [C-]
Recommended: MTH 311

MTH 435, DIFFERENTIAL GEOMETRY, 3
Credits
Differentiable 2-manifolds; curvature; geodesics; tensor algebra and
the algebra of exterior differential forms with emphasis on Euclidean
space; differentiation of tensors and forms; integration of forms; selected
applications. All courses used to satisfy MTH prerequisites must be
completed with C- or better.
Prerequisite: MTH 434 with C- or better or MTH 534 with C- or better

MTH 437, GENERAL RELATIVITY, 3 Credits
Geometry of special relativity. Tensor analysis, metrics, geodesics,
curvature. Einstein field equations, cosmological models, black holes.
Selected topics such as global structure, conserved quantities, spinors.
All courses used to satisfy MTH prerequisites must be completed with C-
or better.
Prerequisite: (MTH 434 with C- or better or MTH 534 with C- or better)
Recommended: MTH 311

MTH 440, COMPUTATIONAL NUMBER
THEORY, 3 Credits
Development of the number theory used in some basic tests of primality
and methods of factoring integers. Applications to cryptology. All courses
used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 231 with C- or better or MTH 343 with C- or better or
MTH 355 with C- or better
MTH 441, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 343 with C- or better and (MTH 342 [C-] or MTH 440 [C-] or MTH 540 [C-])

MTH 442, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 441 with C- or better or MTH 541 with C- or better

MTH 443, ABSTRACT LINEAR ALGEBRA, 3 Credits
Abstract vector spaces. Linear transformations, eigenvalues and eigenvectors, the Jordan canonical form, inner product spaces. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 342 with C- or better or MTH 343 with C- or better

MTH 451, NUMERICAL LINEAR ALGEBRA, 3 Credits
Computation of solutions of linear systems using direct and iterative methods; least-squares solution of overdetermined systems; computation of eigenvalues and eigenvectors. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better
Recommended: Programming experience, MTH 342 and MTH 351

MTH 452, NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of initial-value problems using Runge-Kutta methods and linear multistep methods; introduction to boundary-value problems. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and ((MTH 306 with C- or better or MTH 306H with C- or better) or MTH 341 with C- or better or (MTH 264 with C- or better or MTH 264H with C- or better) and (MTH 253 [C-] or (MTH 265 [C-] or MTH 265H [C-]))
Recommended: MTH 351 or MTH 451 or MTH 551

MTH 453, NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of boundary value problems and initial-boundary value problems using finite difference and finite element methods. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 452 with C- or better or MTH 552 with C- or better

MTH 463, PROBABILITY I, 3 Credits
An introduction to probability theory; topics covered include: the axioms of probability, probability spaces and models, independence, random variables; densities, distributions, expectation, and variance; probability inequalities, the law of large numbers, and the binomial central limit theorem. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 311 (may be taken concurrently) with C- or better

MTH 464, PROBABILITY II, 3 Credits
Transformations of random variables; sums of independent random variables, generating functions, characteristic functions, the central limit theorem and other weak limit theorems. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 463 with C- or better or MTH 563 with C- or better) and MTH 341 [C-]

MTH 465, PROBABILITY III, 3 Credits
Random variables, central limit theorem; distributions of standard statistics; Markov chains, continuous and discontinuous stochastic processes. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 464 with C- or better or MTH 564 with C- or better

MTH 467, ACTUARIAL MATHEMATICS, 3 Credits
Foundations of actuarial science from the point of view of mathematical models that arise in the design and management of insurance systems. Most models will be life insurance based. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 463 with C- or better or MTH 563 with C- or better or ST 421 with C- or better

MTH 480, SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Systems of two first-order differential equations, phase portraits, linearization and the stability of equilibria, conservative systems, reversible systems, limit cycles and the Poincare-Bendixson Theorem. Additional topics selected from Hamiltonian systems, Hopf bifurcation or Lorenz equations and chaos. MTH 480 and MTH 481 cannot both be taken for credit. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 481, APPLIED ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Linear and nonlinear systems of ordinary differential equations, elementary stability theory, higher order equations, boundary value problems, series solution of ordinary differential equations. All courses used to satisfy MTH prerequisites must be completed with a C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and (MTH 253 with C- or better or MTH 253H with C- or better) or (MTH 265 with C- or better or MTH 265H with C- or better) and (MTH 341 [C-] or (MTH 264 [C-] or MTH 264H [C-])) or (MTH 306 [C-] or MTH 306H [C-])
MTH 482, APPLIED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Partial differential equations, Bessel's and Legendre's equations, Fourier analysis, separation of variables, transform methods. All courses used to satisfy MTH prerequisites must be completed with a C- or better.
Prerequisite: MTH 480 with C- or better or MTH 481 with C- or better or MTH 581 with C- or better

MTH 483, COMPLEX VARIABLES, 3 Credits
Introduction to the complex differential and integral calculus: Cauchy's theorem and formula, the residue calculus, power series and Laurent series, harmonic functions, conformal mapping, and applications. All courses used to satisfy MTH prerequisites must be completed with a C- or better.
Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and (MTH 306 [C-] or MTH 306H [C-]) or (MTH 265 [C-] or MTH 265H [C-])

MTH 490, INTENSIVE SUMMER RESEARCH IN MATHEMATICS, 12 Credits
Combination of seminar, lectures, and individual research projects designed to introduce students to research mathematics. This course is repeatable for 99 credits.

MTH 491, ALGEBRA AND GEOMETRIC TRANSFORMATIONS, 3 Credits
Ordered fields, number systems (natural, integer, rational, real, and complex), fundamental theorems of arithmetic and algebra, algebraic and transcendental numbers, constructible points and numbers and the classical geometric constructions, Polya's problem solving heuristics and strategies. Intended primarily for prospective mathematics teachers. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 341 with C- or better

MTH 492, ALGEBRA AND GEOMETRIC TRANSFORMATIONS, 3 Credits
Major results of Euclidean geometry, axiom systems for Euclidean geometry, dependency tree of Euclidean theorems, groups of geometric transformations with applications to symmetries of plane and solid objects, Euler's formula, tilings and tessellations, isometries and similitudes of the plane (translations, rotations, reflections, glide reflections, dilations). Intended primarily for prospective mathematics teachers. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 491 with C- or better

MTH 493, ALGEBRA AND GEOMETRIC TRANSFORMATIONS, 3 Credits
Geometric transformations as real, complex, and matrix functions, invariants and genealogy of geometric transformations, extensions to transformations of the sphere and of three-dimensional space, selected applications chosen from fractals, analysis of frieze and crystallographic patterns, problem solving, groups of symmetries, computer graphics, and the use of dynamic geometry software. Intended primarily for prospective mathematics teachers. All courses used to satisfy MTH prerequisites must be completed with C- or better.
Prerequisite: MTH 492 with C- or better

MTH 499, SPECIAL TOPICS, 0-16 Credits
This course is repeatable for 16 credits.

MTH 501, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MTH 503, THESIS, 1-16 Credits
This course is repeatable for 99 credits.

MTH 505, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

MTH 506, PROJECTS, 1-16 Credits
Graded P/N. This course is repeatable for 16 credits.

MTH 507, SEMINAR, 1-16 Credits
This course is repeatable for 16 credits.

MTH 508, WORKSHOP, 1-16 Credits
This course is repeatable for 16 credits.

MTH 510, OCCUPATIONAL INTERNSHIP, 3-12 Credits
Planned and supervised training experience at selected government, industrial, or business placement sites. Must be followed by a one-hour post-internship seminar. Consult departmental head advisor. Graded P/N. This course is repeatable for 16 credits.

MTH 511, REAL ANALYSIS, 3 Credits
Properties of metric spaces and normed spaces, including lp spaces. Completeness and applications, including fixed point theorems. Compactness. Equicontinuity and the Arzela-Ascoli theorem. Uniform continuity and uniform convergence, including applications. This course is repeatable for 18 credits. Recommended: MTH 312 and MTH 341

MTH 512, REAL ANALYSIS, 3 Credits
Measure and integration theory, basic convergence theorems, Lebesgue spaces, Fubini's theorem, Radon-Nikodym theorem, and applications. Banach spaces including Baire category theorems, and Hilbert spaces. Prerequisite: MTH 511 with C- or better This course is repeatable for 18 credits.

MTH 513, REAL ANALYSIS, 3 Credits
Measure and integration theory, basic convergence theorems, Lebesgue spaces, Fubini's theorem, Radon-Nikodym theorem, and applications. Banach spaces including Baire category theorems, and Hilbert spaces. Prerequisite: MTH 512 with C- or better This course is repeatable for 18 credits.
MTH 520, MODELS AND METHODS OF APPLIED MATHEMATICS, 3 Credits
Discrete and continuous mathematical models and methods for analysis, including linear analysis, equilibrium and minimum principles, calculus of variations, principal component analysis and orthogonal expansions, asymptotic and Fourier analysis, least squares, constrained and unconstrained optimization, inverse problems, and Monte Carlo techniques. Particular models and methods covered may vary annually. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: (MTH 256 or MTH 256H) and MTH 341

MTH 524, DYNAMICAL SYSTEMS THEORY AND APPLICATIONS, 3 Credits
Theory, models, and problems for discrete and/or continuous dynamical systems. Depending on term, the emphasis may be toward deterministic or stochastic systems. Topics generally include stability theory, periodic behavior, and chaotic systems. Models selected from biology, economics, fluid dynamics, and electrical and mechanical systems. May be repeated once for credit with a different topic. All courses used to satisfy MTH prerequisites must be completed with C or better. This course is repeatable for 6 credits.
Recommended: MTH 341 and MTH 342 and MTH 311 and MTH 312 and MTH 361

MTH 525, DYNAMICAL SYSTEMS THEORY AND APPLICATIONS, 3 Credits
Theory, models, and problems for discrete and/or continuous dynamical systems. Depending on term, the emphasis may be toward deterministic or stochastic systems. Topics generally include stability theory, periodic behavior, and chaotic systems. Models selected from biology, economics, fluid dynamics, and electrical and mechanical systems. May be repeated once for credit with a different topic. All courses used to satisfy MTH prerequisites must be completed with C or better. This course is repeatable for 6 credits.
Recommended: MTH 341 and MTH 342 and MTH 311 and MTH 312 and MTH 361

MTH 527, INTRODUCTION TO MATHEMATICAL BIOLOGY, 3 Credits
Modeling and mathematical analysis of biological processes using first principles at scales ranging from the molecular to the population level. Deterministic models are studied in both discrete and continuous time and analyzed using linearization principles, linear and nonlinear stability techniques, phase plane methods, and methods from partial differential equations. Results obtained from mathematical analysis will be qualitatively interpreted and applied to the biological process under investigation. All courses used to satisfy MTH prerequisites must be completed with a C or better.
Recommended: (MTH 256 or MTH 256H) and MTH 341

MTH 528, STOCHASTIC ELEMENTS IN MATHEMATICAL BIOLOGY, 3 Credits
An introduction to stochastic modeling of biological processes. The stochastic models covered may include Markov processes in both continuous and discrete time, urn models, branching processes, and coalescent processes. The biological applications may include genetic drift, population dynamics, genealogy, demography, and epidemiology. Mathematical results will be qualitatively interpreted and applied to the biological process under investigation. All courses used to satisfy MTH prerequisites must be completed with a C or better.
Recommended: MTH 341 and (MTH 361 or MTH 463 or MTH 563)

MTH 531, GENERAL TOPOLOGY AND FUNDAMENTAL GROUPS, 3 Credits
Topological spaces and maps. Separation axioms, compactness, convergence, extension theorems, metrizability and compactification. Product spaces and simplicial complexes. Definition and basic properties of the fundamental group functor, with applications to the theory of covering spaces. Selected topics from dimension theory, manifold theory, and other areas of topology. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 532, GENERAL TOPOLOGY AND FUNDAMENTAL GROUPS, 3 Credits
Topological spaces and maps. Separation axioms, compactness, convergence, extension theorems, metrizability and compactification. Product spaces and simplicial complexes. Definition and basic properties of the fundamental group functor, with applications to the theory of covering spaces. Selected topics from dimension theory, manifold theory, and other areas of topology. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 534, INTRODUCTION TO DIFFERENTIAL GEOMETRY, 3 Credits
Curves and surfaces in Euclidean space; geodesics; curvature; introduction to tensor algebra and differential forms; selected applications. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: (MTH 255 or MTH 255H) and MTH 342 and MTH 311

MTH 535, DIFFERENTIAL GEOMETRY, 3 Credits
Differentiable 2-manifolds; curvature; geodesics; tensor algebra and the algebra of exterior differential forms with emphasis on Euclidean space; differentiation of tensors and forms; integration of forms; selected applications. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 434 or MTH 534

MTH 537, GENERAL RELATIVITY, 3 Credits
Geometry of special relativity. Tensor analysis, metrics, geodesics, curvature. Einstein field equations, cosmological models, black holes. Selected topics such as global structure, conserved quantities, spinors. All courses used to satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 434 with C or better or MTH 534 with C or better
Recommended: MTH 311
MTH 540, COMPUTATIONAL NUMBER THEORY, 3 Credits
Development of the number theory used in some basic tests of primality and methods of factoring integers. Applications to cryptology. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 231 or MTH 343 or MTH 355

MTH 541, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 343 and (MTH 342 or MTH 440 or MTH 540)

MTH 542, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits
Applications of fundamental algebraic systems to topics such as factorization of polynomials, finding roots of polynomials, error correcting codes. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 441 or MTH 541

MTH 543, ABSTRACT LINEAR ALGEBRA, 3 Credits
Abstract vector spaces. Linear transformations, eigenvalues and eigenvectors, the Jordan canonical form, inner product spaces. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 342 and MTH 343

MTH 551, NUMERICAL LINEAR ALGEBRA, 3 Credits
Computation of solutions of linear systems using direct and iterative methods; least-squares solution of overdetermined systems; computation of eigenvalues and eigenvectors. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 341, MTH 342, MTH 351 and programming experience

MTH 552, NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of initial-value problems using Runge-Kutta methods and linear multistep methods; introduction to boundary-value problems. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: Programming experience and (MTH 256 or MTH 256H) and (MTH 306 or MTH 306H or MTH 341) and (MTH 351 or MTH 451 or MTH 551)

MTH 553, NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Numerical solution of boundary value problems and initial-boundary value problems using finite difference and finite element methods. Analysis of stability, accuracy, and implementation of methods. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 452 or MTH 552

MTH 563, PROBABILITY I, 3 Credits
An introduction to probability theory; topics covered include: the axioms of probability, probability spaces and models, independence, random variables; densities, distributions, expectation, and variance; probability inequalities, the law of large numbers, and the binomial central limit theorem. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 312

MTH 564, PROBABILITY II, 3 Credits
Transformations of random variables; sums of independent random variables, generating functions, characteristic functions, the central limit theorem and other weak limit theorems. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 341 and (MTH 463 or MTH 563)

MTH 565, PROBABILITY III, 3 Credits
Random variables, central limit theorem; distributions of standard statistics; Markov chains, continuous and discontinuous stochastic processes. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 464 or MTH 564

MTH 567, ACTUARIAL MATHEMATICS, 3 Credits
Foundations of actuarial science from the point of view of mathematical models that arise in the design and management of insurance systems. Most models will be life insurance based. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: (MTH 463 or MTH 563) or ST 421

MTH 578, PROBABILITY AND DATA ANALYSIS IN K-8 MATHEMATICS, 3 Credits
Key ideas and topics in probability, data analysis, and statistics critical for the mathematics content knowledge of elementary teachers in grades K-8. Based on the recommendations of The Mathematical Education of Teachers by the Conference Board of the Mathematical Sciences. All courses used to satisfy MTH prerequisites must be completed with C or better. Recommended: MTH 390
MTH 581, APPLIED ORDINARY DIFFERENTIAL EQUATIONS, 3 Credits
Linear and nonlinear systems of ordinary differential equations, elementary stability theory, higher order equations, boundary value problems, series solution of ordinary differential equations. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: (MTH 256 or MTH 256H) and (((MTH 253 or MTH 253H) and MTH 341) or (MTH 306 or MTH 306H))

MTH 582, APPLIED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits
Partial differential equations, Bessel's and Legendre's equations, Fourier analysis, separation of variables, transform methods. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 492 or MTH 592

MTH 583, COMPLEX VARIABLES, 3 Credits
Introduction to the complex differential and integral calculus: Cauchy's theorem and formula, the residue calculus, power series and Laurent series, harmonic functions, conformal mapping, and applications. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: (MTH 256 or MTH 256H) and (MTH 253 or MTH 306 or MTH 306H)

MTH 589, TOPOLOGY IN SECONDARY MATHEMATICS, 3 Credits
Key ideas and topics in discrete mathematics critical for the mathematics content knowledge of middle and high school teachers in grades 6-12. Based on the recommendations of The Mathematical Education of Teachers by the Conference Board of the Mathematical Sciences. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 390

MTH 591, ALGEBRA AND GEOMETRIC TRANSFORMATIONS, 3 Credits
Ordered fields, number systems (natural, integer, rational, real, and complex), fundamental theorems of arithmetic and algebra, algebraic and transcendental numbers, constructible points and numbers and the classical geometric constructions, Polyá's problem solving heuristics and strategies. Intended primarily for prospective mathematics teachers. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 341

MTH 592, ALGEBRA AND GEOMETRIC TRANSFORMATIONS, 3 Credits
Major results of Euclidean geometry, axiom systems for Euclidean geometry, dependency tree of Euclidean theorems, groups of geometric transformations with applications to symmetries of plane and solid objects, Euler's formula, tilings and tesselations, isometries and similitudes of the plane (translations, rotations, reflections, glide reflections, dilations). Intended primarily for prospective mathematics teachers. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 491 or MTH 591

MTH 593, ALGEBRA AND GEOMETRIC TRANSFORMATIONS, 3 Credits
Geometric transformations as real, complex, and matrix functions, invariants and genealogy of geometric transformations, extensions to transformations of the sphere and of three-dimensional space, selected applications chosen from fractals, analysis of frieze and crystallographic patterns, problem solving, groups of symmetries, computer graphics, and the use of dynamic geometry software. Intended primarily for prospective mathematics teachers. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 611

MTH 598, PROBABILITY AND DATA ANALYSIS IN SECONDARY MATHEMATICS, 3 Credits
Key ideas and topics in probability, data analysis, and statistics critical for the mathematics content knowledge of middle and high school teachers in grades 6-12. Based on the recommendations of The Mathematical Education of Teachers by the Conference Board of the Mathematical Sciences. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 390

MTH 599, SPECIAL TOPICS, 0-16 Credits
Topics may vary.
This course is repeatable for 18 credits.

MTH 601, RESEARCH, 1-16 Credits
This course is repeatable for 16 credits.

MTH 603, THESIS, 1-16 Credits
This course is repeatable for 99 credits.

MTH 605, READING AND CONFERENCE, 1-16 Credits
This course is repeatable for 16 credits.

MTH 606, SPECIAL PROJECTS, 1-16 Credits
Graded P/N.
This course is repeatable for 16 credits.

MTH 607, SEMINAR, 1-16 Credits
This course is repeatable for 99 credits.

MTH 611, COMPLEX ANALYSIS, 3 Credits
Basic theory of analytic functions of a complex variable, including Cauchy's theorem, residue theorem, analytic continuation, conformal mappings, entire, and meromorphic functions. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 411 or MTH 511

MTH 612, COMPLEX ANALYSIS, 3 Credits
Basic theory of analytic functions of a complex variable, including Cauchy's theorem, residue theorem, analytic continuation, conformal mappings, entire, and meromorphic functions. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 611
MTH 614, FUNCTIONAL ANALYSIS, 3
Credits
Topological vector spaces, generalized functions, operator theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 513

MTH 619, TOPICS IN ANALYSIS, 1-12
Credits
This course is repeatable for 12 credits.

MTH 621, PARTIAL DIFFERENTIAL EQUATIONS, 3
Credits
Partial differential equations of physics, including those of potential theory, wave propagation, and heat flow, treated by classical means, generalized functions and variational principles. Square summable function methods and integral equations. This course is the first in a year-long sequence of MTH 621, MTH 622, MTH 623. All courses used to satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 621 with C or better
This course is repeatable for 6 credits.
Recommended: 6 credits of senior-level analysis

MTH 622, PARTIAL DIFFERENTIAL EQUATIONS, 3
Credits
Partial differential equations of physics, including those of potential theory, wave propagation, and heat flow, treated by classical means, generalized functions and variational principles. Square summable function methods and integral equations. This course is the first in a year-long sequence of MTH 621, MTH 622, MTH 623. All courses used to satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 621 with C or better
This course is repeatable for 6 credits.

MTH 623, PARTIAL DIFFERENTIAL EQUATIONS, 3
Credits
Partial differential equations of physics, including those of potential theory, wave propagation, and heat flow, treated by classical means, generalized functions and variational principles. Square summable function methods and integral equations. This course is the third one in a year-long sequence. All courses used to satisfy MTH prerequisites must be completed with C or better.
Prerequisite: MTH 621 with C or better and MTH 622 [C]
This course is repeatable for 6 credits.

MTH 627, ADVANCED PARTIAL DIFFERENTIAL EQUATIONS, 3
Credits
Advanced theory including existence proofs and distributional approach. Normally offered fall term in odd years. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 6 credits.
Recommended: MTH 413 or MTH 513

MTH 628, ADVANCED PARTIAL DIFFERENTIAL EQUATIONS, 3
Credits
Advanced theory including existence proofs and distributional approach. Normally offered winter term in even years. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 6 credits.
Recommended: MTH 627

MTH 634, ALGEBRAIC TOPOLOGY, 3
Credits
Simplicial and singular homology, products, and cohomology; applications to fixed-point and separation theorems. Topics selected from homotopy, manifold and obstruction theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 532

MTH 635, ALGEBRAIC TOPOLOGY, 3
Credits
Simplicial and singular homology, products, and cohomology; applications to fixed-point and separation theorems. Topics selected from homotopy, manifold and obstruction theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 532 and MTH 634

MTH 636, ALGEBRAIC TOPOLOGY, 3
Credits
Simplicial and singular homology, products, and cohomology; applications to fixed-point and separation theorems. Topics selected from homotopy, manifold and obstruction theory. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 532 and MTH 635

MTH 644, ABSTRACT ALGEBRA I, 3
Credits
Group theory, rings and fields, Galois theory. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 443 or MTH 543

MTH 645, ABSTRACT ALGEBRA II, 3
Credits
Group theory, rings and fields, Galois theory. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 644

MTH 649, TOPICS IN ALGEBRA AND NUMBER THEORY, 3
Credits
This course is repeatable for 27 credits.
MTH 654, NUMERICAL ANALYSIS, 3 Credits
Advanced topics in numerical analysis, such as finite volume methods and finite element methods for partial differential equations, numerical methods for inverse problems, and image processing. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 12 credits.
Recommended: Familiarity with numerical methods

MTH 655, NUMERICAL ANALYSIS, 3 Credits
Advanced topics in numerical analysis, such as finite volume methods and finite element methods for partial differential equations, numerical methods for inverse problems, and image processing. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 12 credits.
Recommended: Familiarity with numerical methods

MTH 656, NUMERICAL ANALYSIS, 3 Credits
Advanced topics in numerical analysis, such as finite volume methods and finite element methods for partial differential equations, numerical methods for inverse problems, and image processing. All courses used to satisfy MTH prerequisites must be completed with C or better.
This course is repeatable for 12 credits.
Recommended: Familiarity with numerical methods

MTH 657, TOPICS IN APPLIED MATHEMATICS, 1-12 Credits
Previous topics have included turbulence, financial mathematics and probability methods in partial differential equations.
This course is repeatable for 12 credits.

MTH 658, TOPICS IN MATHEMATICAL MODELING, 1-12 Credits
Mathematical treatment of topics of current interest in the physical and biological sciences and technology. May be repeated for credit when topic varies.
This course is repeatable for 12 credits.

MTH 659, TOPICS IN NUMERICAL ANALYSIS, 1-12 Credits
This course is repeatable for 12 credits.

MTH 664, PROBABILITY THEORY, 3 Credits
General theory of probability measures and random variables, including weak convergence, characteristic functions, central limit theorem, and the Brownian motion process. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 664

MTH 665, PROBABILITY THEORY, 3 Credits
General theory of probability measures and random variables, including weak convergence, characteristic functions, the central limit theorem, and the Brownian motion process. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 664

MTH 669, TOPICS IN STOCHASTIC PROCESSES, 1-12 Credits
Previous topics have included Markov processes, martingales, branching processes, and stochastic differential equations.
This course is repeatable for 12 credits.

MTH 674, DIFFERENTIAL GEOMETRY OF MANIFOLDS, 3 Credits
Differentiable manifolds, tangent bundles, vector fields and flows, submanifolds, Riemannian metrics, differential forms, integration on manifolds. Selected topics such as foliations, Lie groups, and de Rham cohomology. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 341 and (MTH 411 or MTH 511)

MTH 675, DIFFERENTIAL GEOMETRY OF MANIFOLDS, 3 Credits
Differentiable manifolds, connections in linear bundles, Riemannian manifolds and submanifolds. Selected topics such as variational theory of geodesics, harmonic forms, and characteristic classes. Normally offered alternate years. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: MTH 674

MTH 676, TOPICS IN TOPOLOGY, 3 Credits
This course is repeatable for 27 credits.

MTH 679, TOPICS IN GEOMETRY, 1-12 Credits
This course is repeatable for 12 credits.

MTH 682, TEACHING AND LEARNING PROBABILITY AND STATISTICS, 3 Credits
Experimental, activity-based approaches to introductory probability and statistics are explored. Topics include computer simulations, exploratory data analysis, misuses of statistics, and misconceptions of probability. All courses used to satisfy MTH prerequisites must be completed with C or better.

MTH 684, COMPUTERS AND MATHEMATICS, 3 Credits
A variety of mathematical problems are investigated with a laboratory approach using microcomputers and a wide variety of software. Problems may be taken from number theory, calculus, geometry, probability, and elementary numerical analysis. All courses used to satisfy MTH prerequisites must be completed with C or better.
Recommended: Ability to program in either BASIC or PASCAL
**MTH 685, ADVANCED PROBLEM SOLVING, 3 Credits**
Mathematical problem solving using the heuristic approach of George Polya. Problems may be taken from a variety of areas, including number theory, calculus, geometry, probability, abstract and linear algebra. All courses used to satisfy MTH prerequisites must be completed with C or better.

**MTH 689, TOPICS IN MATHEMATICS EDUCATION, 1-12 Credits**
Topics may vary.
*This course is repeatable for 12 credits.*

**MTH 699, SPECIAL TOPICS, 1-16 Credits**
*This course is repeatable for 16 credits.*