

MATHEMATICS (MTH)

MTH LDEA, LOWER DIVISION ED ABROAD, 0-16 Credits

This course is repeatable for 99 credits.

MTH UDEA, UPPER DIVISION ED ABROAD, 0-16 Credits

This course is repeatable for 99 credits.

MTH 008, +BEYOND OSU II: ENGAGE, 0 Credits

Engage in career-related experiences or activities to gain insights into postgraduation careers in mathematics or related fields. Apply career development concepts to future goals.

Attributes: CSC2 – Core Ed - Beyond OSU Career Engagement

Prerequisite: MTH 201 with C- or better

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.

Prerequisite: Math Placement Test with a score of 05 or Math Placement - ALEKS with a score of 015

Available via Ecampus

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.

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 105Z, +*MATH IN SOCIETY, 4 Credits

Explores present-day applications of mathematics focused on developing numeracy. Major topics include quantitative reasoning and problem-solving strategies, probability and statistics, and financial mathematics; these topics are to be weighted approximately equally. Emphasizes mathematical literacy and communication, relevant everyday applications, and the appropriate use of current technology.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math

Equivalent to: MTH 105

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 111Z, +*PRECALCULUS I: FUNCTIONS, 4 Credits

Designed for students preparing for trigonometry or calculus. Focuses on functions and their properties, including polynomial, rational, exponential, logarithmic, piecewise-defined, and inverse functions. Explores the topics symbolically, numerically, and graphically in real-life applications and interpreted in context. Emphasizes skill building, problem solving, modeling, reasoning, communication, connections with other disciplines, and the appropriate use of present-day technology.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc 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

Equivalent to: MTH 111

Available via Ecampus

MTH 112Z, +*PRECALCULUS II: TRIGONOMETRY, 4 Credits

Designed for students preparing for calculus and related disciplines. Explores trigonometric functions and their applications as well as the language and measurement of angles, triangles, circles, and vectors. Explores the topics symbolically, numerically, and graphically in real-life applications and interpreted in context. Emphasizes skill building, problem solving, modeling, reasoning, communication, connections with other disciplines, and the appropriate use of present-day technology.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math

Prerequisite: MTH 111 with C- or better or MTH 111Z 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 112

Available via Ecampus

MTH 199, SPECIAL TOPICS, 1-9 Credits

This course is repeatable for 9 credits.

MTH 201, +CAREER EXPLORATIONS IN MATHEMATICS, 1 Credit

Explores the Mathematics major, its options, and related careers.

Explores the concepts of professional development. Examines experiential learning and networking opportunities, particularly those related to the fields of mathematics.

Attributes: CSC1 – Core Ed - Beyond OSU Career Preparation

Prerequisite: SCI 100 (may be taken concurrently) with D- or better or SCI 300 (may be taken concurrently) with D- or better or CORE 100 (may be taken concurrently) with D- or better or CORE 300 (may be taken concurrently) with D- or better or BA 100 (may be taken concurrently) with D- or better or BA 300 (may be taken concurrently) with D- or better or ED 100 (may be taken concurrently) with D- or better or ED 300 (may be taken concurrently) with D- or better or LA 100 (may be taken concurrently) with D- or better or LA 300 (may be taken concurrently) with D- or better or ENGR 110 (may be taken concurrently) with D- or better or ENGR 110H (may be taken concurrently) with D- or better or ENGR 310 (may be taken concurrently) with D- or better or Baccalaureate Core Student with a score of 1

MTH 211, *FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits

Introduction to problem solving, sets, whole numbers, number theory, fractions. Intended primarily for prospective elementary teachers.

Attributes: CSMA – Bacc 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 111Z with C- or better or MTH 112 with C- or better or MTH 112Z 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 212, FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits

The second of a three-term sequence 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

Available via Ecampus

MTH 227, +*CALCULUS AND PROBABILITY FOR THE LIFE SCIENCES I, 4 Credits

Reviews exponential and trigonometric functions, including examples of exponential and periodic behavior, specifically with population models; defines discrete probability with biological examples, including conditional probability; investigates and constructs discrete difference equations in life science contexts; defines limits and derivatives, developing these notions with life science examples involving polynomials, exponential and trigonometric functions.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math

Prerequisite: MTH 112 with C- or better or MTH 112Z 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

Available via Ecampus

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.

Prerequisite: MTH 227 with C- or better or MTH 227X with C- or better

Available via Ecampus

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.

Prerequisite: MTH 111 with C- or better or MTH 111Z 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 231H

Available via Ecampus

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.

Attributes: HNRS – Honors Course Designator

Prerequisite: MTH 111 with C- or better or MTH 111Z 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 231

MTH 241, +*CALCULUS FOR MANAGEMENT AND SOCIAL SCIENCE, 4 Credits

Focuses on differential calculus for business, management and social sciences. Explores limits, continuity, derivatives, and their applications for polynomial, logarithmic, and exponential functions. Includes optimization problems, curve sketching, and other applications.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math

Prerequisite: MTH 111 with C- or better or MTH 111Z 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 241H

Available via Ecampus

MTH 241H, +*CALCULUS FOR MANAGEMENT AND SOCIAL SCIENCE, 4 Credits

Focuses on differential calculus for business, management and social sciences. Explores limits, continuity, derivatives, and their applications for polynomial, logarithmic, and exponential functions. Includes optimization problems, curve sketching, and other applications.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math; HNRS – Honors Course Designator

Prerequisite: MTH 111 with C- or better or MTH 111Z 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 241

MTH 245, +*MATHEMATICS FOR MANAGEMENT, LIFE, AND SOCIAL SCIENCES, 4 Credits

Includes techniques of counting, probability and elements of statistics including binomial and normal distributions, introductory matrix algebra and elements of linear programming.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math

Prerequisite: MTH 111 with C- or better or MTH 111Z 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 251HZ, +*DIFFERENTIAL CALCULUS, 4 Credits

Explores limits, continuity, derivatives, and their applications for real-valued functions of a single variable. Explores topics graphically, numerically, and symbolically in real-life applications. Emphasizes abstraction, problem-solving, modeling, reasoning, communication, connections with other disciplines, and the appropriate use of technology.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math; HNRS – Honors Course Designator

Prerequisite: MTH 112 with C- or better or MTH 112Z 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 251H, MTH 251Z

MTH 251Z, +*DIFFERENTIAL CALCULUS, 4 Credits

Explores limits, continuity, derivatives, and their applications for real-valued functions of a single variable. Explores topics graphically, numerically, and symbolically in real-life applications. Emphasizes abstraction, problem-solving, modeling, reasoning, communication, connections with other disciplines, and the appropriate use of technology.

Attributes: CFQL – Core Ed - Quantitative Literacy & Analysis; CSMA – Bacc Core, Skills, Math

Prerequisite: MTH 112 with C- or better or MTH 112Z 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 251H, MTH 251HZ

Available via Ecampus

MTH 252HZ, INTEGRAL CALCULUS, 4 Credits

Explores Riemann sums, definite integrals, and indefinite integrals for real-valued functions of a single variable. Explores topics graphically, numerically, and symbolically in real-life applications. Emphasizes abstraction, problem-solving, modeling, reasoning, communication, connections with other disciplines, and the appropriate use of technology.

Attributes: HNRS – Honors Course Designator

Prerequisite: MTH 251 with C- or better or MTH 251H with C- or better or MTH 251Z with C- or better or MTH 251HZ with C- or better

Equivalent to: MTH 252, MTH 252H, MTH 252Z

MTH 252Z, INTEGRAL CALCULUS, 4 Credits

Explores Riemann sums, definite integrals, and indefinite integrals for real-valued functions of a single variable. Explores topics graphically, numerically, and symbolically in real-life applications. Emphasizes abstraction, problem-solving, modeling, reasoning, communication, connections with other disciplines, and the appropriate use of technology.

Prerequisite: MTH 251 with C- or better or MTH 251H with C- or better or MTH 251Z with C- or better or MTH 251HZ with C- or better

Equivalent to: MTH 252, MTH 252H, MTH 252HZ

Available via Ecampus

MTH 253Z, CALCULUS: SEQUENCES AND SERIES, 4 Credits

Explores real-valued sequences and series, including power and Taylor series. Topics include convergence and divergence tests and applications. Explores topics graphically, numerically, and symbolically. Emphasizes abstraction, problem-solving, reasoning, communication, connections with other disciplines, and the appropriate use of technology.

Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better or MTH 252Z with C- or better or MTH 252HZ with C- or better

Equivalent to: MTH 253

Available via Ecampus

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.

Prerequisite: MTH 252Z with C- or better or MTH 252HZ with C- or better or 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.

Attributes: HNRS – Honors Course Designator

Prerequisite: MTH 252Z with C- or better or MTH 252HZ with C- or better or 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.

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.

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.)

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.)

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 252Z with C- or better or MTH 252HZ with C- or better or MTH 252 with C- or better or MTH 252H with C- or better

Equivalent to: MTH 264H

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 252Z with C- or better or MTH 252HZ with C- or better or MTH 252 with C- or better or MTH 252H with C- or better

Equivalent to: MTH 264

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 252Z with C- or better or MTH 252HZ with C- or better or MTH 252 with C- or better or MTH 252H with C- or better

Equivalent to: MTH 265H

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 252Z with C- or better or MTH 252HZ with C- or better or MTH 252 with C- or better or MTH 252H with C- or better

Equivalent to: MTH 265

MTH 267, LINEAR ALGEBRA FOR DATA SCIENCE, 3 Credits

Explores aspects of Linear Algebra relevant to the rapidly developing field of data science. Combines standard "by hand" approaches to low dimensional systems, with application to high dimensional data via MATLAB projects. Emphasizes vector and matrix algebra, applications to statistics, common matrix decompositions, and principal component analysis. Develops skills in computation, visualization, and communication.

MTH 299, SPECIAL TOPICS, 1-9 Credits

This course is repeatable for 9 credits.

MTH 301, +INTEGRAL HISTORIES AND SOCIAL ISSUES IN MATHEMATICS, 3 Credits

Engages with the contributions and erasure of mathematics by historically marginalized populations through colonization, appropriation of mathematics, and prioritization of Eurocentric identities. Addresses the modern-day issues faced by diverse mathematicians, and how mathematics is used to oppress and discriminate. Explores the mathematics contributed by populations such as American indigenous people and women.

Attributes: CSDP – Core Ed - Advanced Difference, Power & Oppression

Recommended: Completion of a Difference, Power, and Oppression Foundations course; Analytical, critical thinking, and synthesis skills

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.

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.

Attributes: HNRS – Honors Course Designator

Prerequisite: MTH 252 with C- or better or MTH 252H with C- or better

Equivalent to: MTH 306

MTH 310, FOUNDATIONS OF MATHEMATICS, 3 Credits

Introduces proof writing and focuses on elementary logic and set theory, quantifiers, proof techniques (including mathematical induction), equivalence relations, and functions. Topics include recurrence relations, generating functions, the binomial theorem, and cardinality of sets.

Prerequisite: MTH 253 (may be taken concurrently) with C- or better or MTH 253Z (may be taken concurrently) with C- or better

Equivalent to: MTH 355

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.

Prerequisite: (MTH 254 with C- or better or MTH 254H with C- or better) and (MTH 355 [C-] or MTH 310 [C-])

MTH 312, ADVANCED CALCULUS II, 4 Credits

Rigorous development of calculus, axiomatic properties of \mathbb{R} , 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.

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.

Attributes: CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (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.

Attributes: CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (WIC)

Prerequisite: MTH 341 with C- or better or MTH 355 with C- or better or MTH 310 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.

Attributes: CSWC – Core Ed - Writing Intensive Curriculum (WIC); CWIC – Bacc Core, Skills, Writing Intensive Curriculum (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
Available via Ecampus

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.

Prerequisite: MTH 341 with C- or better

Available via Ecampus

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.

Prerequisite: MTH 341 with C- or better and (MTH 355 [C-] or MTH 310 [C-])

MTH 351, INTRODUCTION TO NUMERICAL ANALYSIS, 3 Credits

Introduces 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 and differentiation; numerical linear algebra.

Prerequisite: MTH 341 with C- or better or MTH 306 with C- or better or MTH 306H with C- or better or MTH 264 with C- or better or MTH 264H with C- or better

Recommended: Programming experience, Taylor Expansions

Available via Ecampus

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.

Prerequisite: MTH 253Z with C- or better or MTH 253 with C- or better

Equivalent to: MTH 310

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.

Prerequisite: MTH 253Z with C- or better or 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

Available via Ecampus

MTH 390, FOUNDATIONS OF ELEMENTARY MATHEMATICS, 4 Credits

The third of a three-term sequence 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

Equivalent to: MTH 399H

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

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.

This course is repeatable for 16 credits.

MTH 411, REAL ANALYSIS, 3 Credits

Properties of metric spaces and normed spaces, including l_p 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 419, MULTIVARIABLE ADVANCED CALCULUS, 3 Credits

A rigorous development of multivariable advanced calculus, including continuity and compactness in multivariable Euclidean spaces, differentiation and approximation of multivariable functions, the inverse function theorem and the implicit function theorem, integration in several variables.

Prerequisite: MTH 312 with B or better

MTH 420, 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.

Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

MTH 427, 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.

Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and MTH 341 [C-]

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])

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.

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.

Prerequisite: MTH 434 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.

Prerequisite: MTH 231 with C- or better or MTH 231H with C- or better or MTH 343 with C- or better or MTH 355 with C- or better or MTH 310 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.

Prerequisite: MTH 343 with C- or better and (MTH 342 [C-] or MTH 440 [C-])

MTH 442, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits

Applies fundamental algebraic systems to a variety of topics, with an emphasis on Groebner bases, utilizing a computational perspective. Multivariable Division Algorithm, Hilbert Basis Theorem, (effective) Nullstellensatz, term orders, S-polynomials, Buchberger's algorithm, Groebner bases. Applications may include graph coloring, integer programming, ideal membership, polynomial maps.

Prerequisite: MTH 343 with C- or better and (MTH 342 [C-] or MTH 440 [C-] or MTH 441 [C-])

MTH 443, ABSTRACT LINEAR ALGEBRA, 3 Credits

Focuses on abstract vector spaces. Topics including linear transformations, eigenvalues and eigenvectors, the Jordan canonical form, and inner product spaces.

Prerequisite: MTH 342 with C- or better and MTH 343 [C-]

MTH 444, ABSTRACT ALGEBRA, 3 Credits

Focuses on group actions, Sylow theory, the classification of finitely generated abelian groups, and an introduction to the theory of algebraic field extensions and Galois theory.

Prerequisite: 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.

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.

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 253Z [C-] or MTH 253 [C-] or (MTH 265 [C-] or MTH 265H [C-]))

Recommended: MTH 351 or MTH 451

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.

Prerequisite: MTH 452 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.

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.

Prerequisite: MTH 341 with C- or better and MTH 463 [C-]

MTH 465, PROBABILITY III, 3 Credits

Random variables, central limit theorem; distributions of standard statistics; Markov chains, continuous and discontinuous stochastic processes.

Prerequisite: MTH 464 with C- or better

MTH 467, ACTUARIAL MATHEMATICS, 3 Credits

Explores foundations of actuarial science from the point of view of mathematical models that arise in the design and management of insurance systems. Utilizes life insurance-based models. Covers the basics of risk and insurance: risk, loss, claims, net premium, deductibles, aggregate loss, proportional reinsurance, and excess of loss reinsurance. Introduces and establishes basic properties of classical risk process, such as the Cramér Lundberg model utilizing probabilistic tools.

Prerequisite: MTH 361 with C- or better or MTH 463 with C- or better or ST 421 with C- or better

Available via Ecampus

MTH 470, MATHEMATICS OF DATA SCIENCE, 3 Credits

Explores the mathematical foundations of data science, including topics such as applied harmonic analysis, gradient-based optimization, graph theory, high-dimensional geometry, randomized algorithms, and spectral theory. Emphasizes mathematical frameworks alongside computational exercises. Examines mathematical principles behind data science applications.

Prerequisite: MTH 342 with C- or better

Recommended: Programming experience

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 Poincaré-Bendixson Theorem. Additional topics selected from Hamiltonian systems, Hopf bifurcation or Lorenz equations and chaos.

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.

Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and ((MTH 253Z with C- or better or MTH 253 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.

Prerequisite: MTH 480 with C- or better or MTH 481 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.

Prerequisite: (MTH 256 with C- or better or MTH 256H with C- or better) and (MTH 253Z [C-] or MTH 253 [C-] or 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.

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.

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.

Prerequisite: MTH 492 with C- or better

MTH 499, SPECIAL TOPICS, 1-16 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 999 credits.

MTH 505, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

MTH 506, PROJECTS, 1-16 Credits

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.

This course is repeatable for 16 credits.

MTH 511, REAL ANALYSIS, 3 Credits

Properties of metric spaces and normed spaces, including l_p 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.

Recommended: MTH 256 and MTH 341

MTH 524, DYNAMICAL SYSTEMS I, 3 Credits

Explores theory of dynamical systems and illustrates it on examples of those systems. Topics include invariant sets, transitivity and ergodicity, limit sets, conjugacy and factor mappings, and Sharkovskii's theorem.

This course is repeatable for 6 credits.

Recommended: MTH 342 and MTH 311 and MTH 312

MTH 525, DYNAMICAL SYSTEMS II, 3 Credits

Explores the theory of dynamical systems and illustrates it on examples of those systems. Topics include attraction to and stability of invariant sets, recurrence, almost periodicity, non-wandering points and chain recurrence, shift spaces, and ergodic theory.

This course is repeatable for 6 credits.

Recommended: MTH 524

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.

Recommended: MTH 256 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.

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.

Recommended: MTH 255 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.

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 cryptography.

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.

Recommended: MTH 343 and (MTH 342 or MTH 440 or MTH 540)

MTH 542, APPLIED AND COMPUTATIONAL ALGEBRA, 3 Credits

Applies fundamental algebraic systems to a variety of topics, with an emphasis on Groebner bases, utilizing a computational perspective. Multivariable Division Algorithm, Hilbert Basis Theorem, (effective) Nullstellensatz, term orders, S-polynomials, Buchberger's algorithm, Groebner bases. Applications may include graph coloring, integer programming, ideal membership, polynomial maps.

Prerequisite: MTH 540 with C or better or MTH 541 with C or better

MTH 543, ABSTRACT LINEAR ALGEBRA, 3 Credits

Focuses on abstract vector spaces. Topics including linear transformations, eigenvalues and eigenvectors, the Jordan canonical form, and inner product spaces.

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.

Recommended: Programming experience and MTH 256 and (MTH 306 or MTH 341 or MTH 264) and (MTH 253 or MTH 265) 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.

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.

Recommended: MTH 311

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.

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.

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 570, MATHEMATICS OF DATA SCIENCE, 3 Credits

Explores the mathematical foundations of data science, including topics such as applied harmonic analysis, gradient-based optimization, graph theory, high-dimensional geometry, randomized algorithms, and spectral theory. Emphasizes mathematical frameworks alongside computational exercises. Examines mathematical principles behind data science applications.

Recommended: Programming experience (Python, Julia, MATLAB, or similar), Probability (MTH 361, ST 421, MTH 463, or similar), Advanced linear algebra (MTH 443, MTH 451, or similar)

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.

Recommended: MTH 256 and (MTH 253 or MTH 265) and (MTH 341 or MTH 264 or MTH 306)

MTH 582, APPLIED PARTIAL DIFFERENTIAL EQUATIONS, 3 Credits

Partial differential equations, Bessel's and Legendre's equations, Fourier analysis, separation of variables, transform methods.

Recommended: MTH 480 or MTH 481 or MTH 581

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.

Recommended: MTH 256 and (MTH 253 or MTH 306 or MTH 265)

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, Polya's problem solving heuristics and strategies. Intended primarily for prospective mathematics teachers.

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 tessellations, isometries and similitudes of the plane (translations, rotations, reflections, glide reflections, dilations). Intended primarily for prospective mathematics teachers.

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.

Recommended: MTH 492 or MTH 592

MTH 599, SPECIAL TOPICS, 1-16 Credits

Topics may vary.

This course is repeatable for 18 credits.

Available via Ecampus

MTH 601, RESEARCH, 1-16 Credits

This course is repeatable for 16 credits.

MTH 603, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

MTH 605, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

MTH 606, SPECIAL PROJECTS, 1-16 Credits

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 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. The first course in a year-long sequence.

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. The second course in a year-long sequence.

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. The third course in a year-long sequence.

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 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 theory, conditional expectations, martingales. All courses used to satisfy MTH prerequisites must be completed with C or better.

Recommended: MTH 411 or MTH 511

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 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

This course is repeatable for 12 credits.

Available via Ecampus

MTH 699, SPECIAL TOPICS, 1-16 Credits

This course is repeatable for 16 credits.