

MATHEMATICS

the courses

MATH 070: 3 s.h.

Essential Mathematics

This course focuses on computational and problem-solving skills that students need to prepare them for the mathematical prerequisites in their chosen fields of study. Additionally the course is designed to build financial skills required for life success (e.g. financial management, budgeting, and so forth). The individual mathematical topics will be covered as needed by individual students in the class based on his/her current abilities. Potential topics of study will include addition, subtraction, multiplication, and division of whole numbers, rational numbers; study and application of ratio, proportion, and percent; applied topics dealing with measurement, areas and perimeters of geometric figures, and basic descriptive statistics. This course is taught in a hybrid learning environment including (but not limited to) face-to-face instruction/lecture, online video instruction, individual one-on-one coaching/tutoring, and adaptive learning computer technology. MATH 070 course credit cannot be counted towards fulfillment of a baccalaureate or associate degree.

MATH 079: 1-4 s.h.

Experimental/Developmental

Experimental Course for Pre-College Level study in Mathematics. Does not count toward 120 credits for degree completion.

MATH 090: 3 s.h.

Basic Mathematics

For students who need additional preparation before taking a college mathematics course. Remedial in nature and not applicable toward the science/math requirement. After successfully completing MATH 090, students are prepared to take courses that fulfill this requirement. Students who must take MATH 090 earn course credits, and the grade is counted in the cumulative grade point average, but MATH 090 course credit cannot be counted towards fulfillment of the baccalaureate or associate degree.

MATH 094: 2 s.h.

Fundamentals of Math I (MATH 104), Supplemental

Mathematics content that elementary and special education teachers of mathematics at any level need to know and understand before beginning to teach. Includes number systems, structure of algorithms, number theory, properties of integers, rational and real numbers, and beginning geometry and measurement. Emphasis on problem solving and reasoning within each topic.

MATH 100: 3 s.h.

Survey of Mathematical Ideas (G2)

A liberal arts course for students who will not be scheduling a technical/professional math course. A survey of mathematics important to the history of Western civilization and to the modern world. Introductory modules covered usually include number theory, geometry, topology, probability, statistics, graph theory, consumer mathematics and set theory. No credit in math/science block for math and science majors. Prereq: MATH 090 with a grade of C- or higher or math placement testing/evaluation before registration. Only one of MATH 100, 102, 107, and 108 may be taken for general education credit.

MATH 101: 3-5 s.h.

College Algebra

For students who need to improve their algebraic skills before taking a higher-level course such as MATH 151, 160 or 161; focuses on algebraic topics needed for success in college mathematics and its applications. Includes the real number system, linear equations and inequalities, word problems, polynomials and factoring, rational algebraic expressions, exponents and radicals, quadratic equations, irrational equations, graphs of equations, systems of equations and logarithmic and exponential functions. Prereq: high school algebra I, II and geometry; math placement testing/ evaluation before registration.

MATH 102: 3 s.h.

Math in Non-European Cultures (D, G2)

A survey of mathematical ideas developed by non-European cultures, including, but not limited to, those of Africans, Asians and native North, Central and South Americans. Includes culture and specific examples from the following areas of mathematics: number theory, topology, probability, group theory and logic. No credit under block G2 for math or science majors. Prereq: MATH 090 with a grade of C- or higher, math placement testing/ evaluation before registration. Only one of MATH 100, 102, 107, and 108 may be taken for general education credit.

MATH 104: 3 s.h.

Fundamentals of Math 1 (G2)

Mathematics content that elementary and special education teachers of mathematics at any level need to know and understand before beginning to teach. Designed to equip all such majors with sufficient knowledge and facility in mathematics for teaching it effectively. Includes sets and logic, number systems, structure of algorithms, number theory, properties of integers, rational numbers and real numbers, and beginning geometry and measurement. Emphasis on problem solving and reasoning within each topic. Required of all early childhood education and middle level majors. Prereq: math placement testing/evaluation before registration.

MATH 105: 3 s.h.

Fundamentals of Math 2 (G2)

An extension of MATH 104; covers additional mathematics topics relevant to teaching elementary mathematics. Includes algebra, additional study in geometry and measurement, probability and statistics, graphing and further emphasis on problem solving and reasoning. Required of all early childhood education majors. Prereq: C or higher in MATH 104 and passing score on the basic skills test. MATH 230 and 205 are equivalent courses, credit will not be given for MATH 105, 230 and/or 205.

MATH 107: 3 s.h.

Math Survey: Sports & Games (G2)

A liberal arts course for students who will not be scheduling a technical/professional mathematics course. Explores topics in mathematics through the lens of sports, athletic competitions, and games. Introductory modules may include (but not be limited to): number theory, geometry/measurement, algebra, probability, statistics, voting methods, and graph theory. No credit under G2 block for math or science majors. Only one of MATH 100, 102, 107, and 108 may be taken for general education credit. Prereq: MATH 090 with a grade of C-minus or higher or MPT 100.

MATH 108: 3 s.h.**Math Survey: Art & Music (G2)**

A liberal arts course for students who will not be scheduling a technical/professional mathematics course. Explores topics in mathematics through the lens of the fine arts, which may include (but is not limited to) architecture, visual arts, music, and dance. Mathematical content covered may include geometry, transformations, patterns, algebra, sequences and series, permutations, number theory, and fractals. No credit under G2 block for math or science majors. Only one of MATH 100, 102, 107, and 108 may be taken for general education credit. Prereq: MATH 090 with a grade of C-minus or higher or MPT 100.

MATH 110: 2 s.h.**Trigonometry**

For students preparing to take calculus who need additional background in trigonometry. Beginning with angles, numerical trigonometry and triangle solving, it develops the concepts and analytical skills required in calculus: identities, inverse functions, trigonometric equations, graphs and applications. Prereq: MATH 101 or math placement testing/evaluation before registration and high school algebra I, II and geometry.

MATH 120: 2 s.h.**Logic for Information Technology (G2)**

Discrete mathematics and its applications to technology including formal mathematical notation, propositional logic, predicate logic, set theory, relations, functions, and matrices. No credit toward a math or four-year computer science major. Prereq: MPT 120 or C- or higher in MATH 101.

MATH 130: 3 s.h.**Elements of Statistics 1 (G2)**

Derivation of basic formulas; measures of central tendency and variability; probability and normal curve; sampling and hypothesis testing; confidence intervals. No credit toward a math or four-year computer science major, or under block G2 for majors in the College of Science and Technology except for nursing majors and allied health technology majors. Prereq: any 100-level MATH course or math placement testing/evaluation before registration. MATH 234 and MATH 235 are equivalent courses, credit will not be given for MATH 130, 234 and/or 235.

MATH 151: 4 s.h.**Calculus for Management (G2)**

Elementary calculus and its applications in business, economics, life and social sciences. Functions, limits and continuity. The derivative, applications in marginal analysis, optimization, differentials and error estimation. Antiderivatives, area under a curve and definite integrals; integration by parts. Exponential and logarithm functions; applications to growth and decay problems. Improper integrals. No credit toward a major or minor in mathematics. Prereq: MATH 101 or equivalent with a grade of C- or higher, or math placement testing/evaluation before registration. Credit will not be granted for more than one course from MATH 151, 161 or 163H. These courses are considered equivalent and will be processed as repeat credit.

MATH 160: 4 s.h.**Precalculus (G2)**

For students preparing to take Calculus I (MATH 161) who need additional background. Covers topics in which beginning calculus students are often deficient: elementary functions, curve sketching, theory of equations, inequalities, trigonometry and analytic geometry. No credit toward a math major. Prereq: two years of high school algebra, one year of high school geometry and trigonometry, and math placement testing/evaluation before registration; or MATH 101.

MATH 161: 4 s.h.**Calculus 1 (G2)**

Introduces concepts and techniques of calculus, beginning with limits. Major emphasis is on the theory and applications of limits, continuity, derivatives, antiderivatives and the definite integral. Includes introductory calculus of trigonometric, inverse trigonometric, exponential and logarithmic functions. Prereq: C- or higher in MATH 160 or math placement testing/evaluation before registration. Credit will not be granted for more than one course from MATH 151, 161 or 163H. These courses are considered equivalent and will be processed as repeat credit.

MATH 161H: 4 s.h.**Hon: Calculus 1 (G2)****MATH 163H: 5 s.h.****Honors Calculus 1 (G2)**

The progression of mathematical concepts, in the context of the thought and civilization of the time, from the Babylonians to the 20th century. Focus on the contributions of the Hellenic and Alexandrian Greeks as a point of departure for the evolution of geometry, number theory, analysis and logic. Proofs of some of the great theorems. Offered in fall, spring and periodically in summer. Credit will not be granted for more than one course from MATH 151, 161 or 163H. These courses are considered equivalent and will be processed as repeat credit.

MATH 179: 4 s.h.**Experimental**

Experimental

MATH 204: 3 s.h.**Algebraic Foundations for Mid-Level Teacher (G2)**

Designed for middle-level (4-8) teacher candidates. It contains a concrete study of algebraic structures encountered in the middle-level school mathematics curriculum. Content includes sequential patterns and examples and properties of rings and integral domains such as the integers, integers mod n , polynomials and matrices. Prereq: passing score on BST, and grade of C or better in MATH 104 or department permission. For middle level education majors only.

MATH 205: 3 s.h.**Geometry for the Middle-Level Teacher (G2)**

Designed to equip middle-level (4-8) teacher candidates with sufficient knowledge and mathematical experiences for teaching geometry and measurement effectively. Includes the study of two-dimensional and three-dimensional figures, geometric constructions, congruence, similarity, angle measure, distance, area and volume. Connections between geometry and other mathematics topics; nature and art are addressed. Prereq: passing score on BST, and C or better in MATH 104 or department permission. For middle-level education majors only. MATH 105 is an equivalent course, credit will not be given for MATH 105 and 205.

MATH 211: 4 s.h.**Calculus 2 (G2)**

Continuation of MATH 161. Techniques of integration, applications of the definite integral, improper integrals, parametric equations, polar coordinates, sequences and infinite series. Prereq: C- or higher in MATH 161 or 163.

MATH 230: 3 s.h.**Probability and Stats for Mid-Level Teacher (G2)**

Designed for middle-level (4-8) teaching candidates as an introduction to probability and statistics. Course will cover the following topics at an appropriate level: descriptive statistics, counting and basic probability, concept of random sampling, random variables and probability distributions, and statistical inference involving confidence intervals and hypothesis testing. Prereq: passing score on BST and C or better in MATH 104 or department permission. For middle-level education majors only. MATH 105 is an equivalent course, credit will not be given for MATH 105 and 230.

MATH 234: 4 s.h.**Statistics for Health Sciences (G2)**

For nursing program and other health science students. Descriptive statistics, odds ratios, counting, basic probability, concept of random sampling, random variables, probability distributions, and statistical inference including confidence interval estimation and hypothesis testing for one and two sample problems involving means and proportions, chi-squared tests, one way ANOVA, simple linear regression, and correlation will be covered at an appropriate level. Prereq: Math Placement or a 100 level MATH course. MATH 130 and MATH 235 are equivalent courses, credit will not be given for MATH 130, 234 and/or 235.

MATH 235: 3 s.h.**Survey of Statistics (G2)**

A survey of elementary probability theory, estimation, hypothesis testing and simple regression and correlation. Interpretation of statistical inference in the analysis of data. Emphasis on applications in both behavioral and physical sciences. Prereq: MATH 101 or MATH 151 or higher, or math placement of MATH 151 or higher. MATH 130 and MATH 234 are equivalent courses, credit will not be given for MATH 130, 234 and/or 235.

MATH 236: 3 s.h.**Elements of Statistics 2 (G2)**

An extension of MATH 130 or MATH 235. Includes estimation, hypothesis testing, design of experiments with analysis of variance, regression analysis, covariance analysis and nonparametric approaches. Includes experiences using a variety of computing devices. A substantial methods course for any major who needs to use statistical techniques. No credit toward math major. Offered in spring. Prereq: MATH 130 or MATH 235.

MATH 255: 3 s.h.**Intro to Data Analytics**

Introduction to data analysis techniques and programming that enables real-time decision making in IT organizations. Includes skills and applications in pre-processing, preparing, and reporting data for further analysis. (Cross-listed with INTE 255, credit may not be received for both courses.)

MATH 256: 4 s.h.**Data Visualization and Communication (G2)**

This course is the continued exploration and application of data analysis techniques and programming that allows for the cleanup, analysis, interpretation, and presentation of business-related data. Includes skills and applications in pre-processing, preparing, reporting, and presenting data for further analysis. Students will be exposed to datasets created and managed by business organizations, and learn to ask salient strategic and operational questions based on the information contained within the datasets. Students will analyze statistical relations between variables, create visual depictions of the relations inherent in the data, and communicate their findings to broad audiences in oral and written formats. Prereq: C- or higher in MATH 235.

MATH 279: 1-4 s.h.**Experimental**

Experimental

MATH 300: 3-12 s.h.**Co-Op Ed Experience in Math**

Co-Op Ed Experience in Math

MATH 301: 3 s.h.**History of Mathematics (P)**

The progression of mathematical concepts in the context of the thought and civilization of the time, from the Babylonians to the 20th century. Focus on the contributions of the Hellenic and Alexandrian Greeks as a point of departure for the evolution of geometry, number theory, analysis and logic. Proofs of some of the great theorems. Prereq: COMM 100, ENGL 110, MATH 151 or 156 or 161 or 163, and junior status.

MATH 301H: 3 s.h.**Hnrs:History of Mathematics (P)**

The progression of mathematical concepts in the context of the thought and civilization of the time, from the Babylonians to the 20th century. Focus on the contributions of the Hellenic and Alexandrian Greeks as a point of departure for the evolution of geometry, number theory, analysis and logic. Proofs of some of the great theorems. Prereq: COMM 100, ENGL 110, MATH 151 or 156 or 161 or 163, and junior status.

MATH 304: 4 s.h.**Matrix Algebra & Applications**

An introduction to matrix algebra with emphasis on applications: systems of linear equations, matrix algebra, determinants, Euclidean and general vector spaces, inner product spaces, eigenvalues and eigenvectors, matrix transformations, numerical methods for matrices, selected applications such as Markov chains, strategy games, cryptography, bar codes, Hadamard matrices, error-correcting codes, graph theory, computer graphics and internet search engines. Credit will not be granted for both MATH 304 and 322. Prereq: C- or better in MATH 161/163H.

MATH 305: 2 s.h.**Teaching Math in Secondary Schools 1**

The first of two secondary mathematics methods courses, participants will investigate mathematics teaching and learning from both teacher and student perspectives. Course participants will engage in mathematical problem solving and in the study of mathematics as the foundation for understanding current curriculum and standards. Lesson planning follows from the consideration of different types of mathematical content, including skills and concepts. Looking specifically at the learning of mathematics and questioning to promote higher-level thinking, this course prepares students for field experiences in subsequent semesters. Recommended: take concurrently with EDFN 211 and EDFN 241. Pre/Coreq: C- or higher in MATH 211.

MATH 310: 3 s.h.**Intro to Mathematical Proof (W)**

Emphasizes mathematical reasoning and communication of mathematical ideas both orally and in writing. Symbolic logic. Techniques of mathematical proof. Algebra of sets, binary relations and functions. Infinite sets, both countable and uncountable. Prereq: ENGL 110 and C- or higher in MATH 211.

MATH 310H: 3 s.h.**Hon: Intro to Mathematic Proof (W)**

MATH 311: 4 s.h.**Calculus 3 (G2)**

Continuation of MATH 211. Vector calculus, functions of several real variables, partial differentiation, implicit functions, multiple integrals, line and surface integrals and applications. Prereq: C- or higher in MATH 211.

MATH 312: 1 s.h.**Software for Multivariable Calc**

This course will introduce students to a computer algebra system and programming language of use in understanding multivariable calculus. Assuming no prior experience with this software, the students will learn how to evaluate algebraic expressions, plot functions and perform many operations common in calculus, such as integration and differentiation. Students will develop skills with this software that are useful for the visualization and manipulation of multivariable and vector-valued functions. Offered infrequently. Coreq: C- or higher in MATH 311.

MATH 319: 1 s.h.**Calculus and Actuarial Prbl Slvg**

An extension and synthesis of the calculus sequence that provides students with the problem-solving skills emphasized in such examinations as the Society of Actuaries Exam 1. Does not count as an upper-division elective for the mathematics major or minor. Offered in spring. Prereq: C- or higher in MATH 311.

MATH 322: 4 s.h.**Linear Algebra 1 (G2)**

A rigorous introduction to linear algebra. Includes systems of linear equations, matrix algebra, determinants, vector spaces, inner product spaces geometry in R^n , linear transformations, orthogonal transformations, eigentheory and diagonalization. Prereq or coreq: C- or higher in MATH 311; MATH 310 recommended. Credit will not be given for this course and MATH 304. MATH 322 is intended for mathematics majors and is more theory and proof-based. MATH 304 is more application oriented and intended for computer science or data science majors

MATH 325: 3 s.h.**Mathematical Connections**

Mathematical Connections is a 3-credit required course for BSE mathematics majors. Pre-service secondary mathematics teachers (middle and high school) will explore the nature of the mathematics that they will teach through the lens of the undergraduate mathematics courses that they have taken as part of their required program. Mathematical topics will include number systems, functions, number theory, trigonometry, geometry (Euclidean and non-Euclidean), calculus, and statistics. The course will include an examination of concept analysis, problem analysis and mathematical connections between standard secondary mathematics content and post-secondary mathematics coursework. The course will actively involve pre-service teachers in a productive dialogue about and rigorous investigation into the mathematics that they will teach. Restricted to BSE majors. Pre/ Coreq: C- or higher in MATH 333, and MATH 345, and MATH 354 or permission of instructor.

MATH 333: 4 s.h.**Probability and Statistics**

Designed for mathematics education majors. A rigorous study of probability, distribution theory and the basics of statistical inference. Includes probability, expectation, discrete and continuous distributions, descriptive statistics and both estimation and hypothesis testing for one- and two-sample problems. Credit will not be granted for both MATH 333 and MATH 335. Prereq: C- or higher in MATH 311.

MATH 335: 3 s.h.**Mathematical Statistics 1**

Probability, random variables and probability distributions, mathematical expectation, special probability distributions and probability densities. MATH 335 may be considered as an introductory course in probability theory. Offered in fall. Credit will not be granted for both MATH 333 and MATH 335. Prereq: C- or higher in MATH 311.

MATH 345: 3 s.h.**Abstract Algebra 1**

Groups, rings, fields, integral domains. Emphasis on structure of algebra. Prereq: C- or higher in MATH 310 and 322.

MATH 353: 3 s.h.**Survey of Geometry**

Various examples of axiom systems, axiomatic development of Neutral Geometry followed by Euclidean and Hyperbolic Geometry. Models for Euclidean and Hyperbolic Geometry. Emphasis on proving geometric theorems, both orally and in writing. Prereq: C- or higher in MATH 310 and 322 or permission of instructor.

MATH 354: 4 s.h.**Classical and Transformational Geometry**

Geometry from both classical and transformational points of view. The classical part of the course will focus on the axiomatic development of neutral geometry followed by Euclidean and hyperbolic geometry. The transformational part of the course will begin with the study of two families of transformations: isometries and similarities, followed by the investigation of various geometric theorems in terms of these two families of transformations. Emphasis on proving geometric theorems using both classical and transformational approaches. Prereq: C- or better: MATH 310 and MATH 322.

MATH 355: 3 s.h.**Transformational Geometry**

The study of geometry from a transformational point of view. The group of affine transformations, with the subgroups of similarities and motions, is studied with investigation of invariant properties. Some exposure to transformations in the complex plane. Prereq: C- or higher in MATH 310 and 322 or permission of instructor.

MATH 355H: 3 s.h.**H: Transformational Geometry****MATH 365: 3 s.h.****Ordinary Differential Equation**

First-order differential equations; linear first- and second-order initial-value problems; power series solutions; applications. Also includes at least one of the following topics: special functions of mathematical physics, Laplace transforms, systems of first-order equations. Offered in fall, spring. Prereq: C- or higher in MATH 311.

MATH 370: 3 s.h.**Operations Research**

Principles of model building; examples from linear optimization, network analysis, dynamic programming, probabilistic decision theory, Markov chains, queuing theory, simulation and inventory models. Applications and theory will be examined. Offered periodically. Prereq: C- or higher in MATH 322 and one of MATH 235, 333 or 335 or permission of instructor.

MATH 372: 3 s.h.**Financial Mathematics I**

Provides an understanding of the fundamental concepts of financial mathematics, and how those concepts are applied in calculating present and accumulated values for various streams of cash flows as a basis for future use in: reserving, valuation, pricing, asset/liability management, investment income, capital budgeting, and valuing contingent cash flows. Prereq: C- or better in MATH 211

MATH 375: 3 s.h.**Numerical Analysis**

Numerical methods for solving systems of linear equations, solving nonlinear equations, integration, interpolation, approximation and least squares curve fitting. Error theory. Offered in spring. Prereq: C- or higher in CSCI 161, MATH 311 and 322.

MATH 379: 3 s.h.**Experimental**

Experimental

MATH 393: 3 s.h.**Number Theory**

The study of the properties of integers with respect to the fundamental operations. Primary emphasis on the logical derivations of these properties. Includes induction, divisibility, congruences, theorems of Fermat and Euler, continued fractions and quadratic reciprocity. Offered periodically. Prereq: C- or higher in MATH 310.

MATH 393H: 3 s.h.**H:Number Theory**

H:Number Theory

MATH 395: 3 s.h.**Introduction Combinatorics**

Mathematical foundation for the concepts and techniques used in combinatorics. Topics include recurrence relations, finite differences, generating functions, pigeonhole principle, special sequences of integers (such as Fibonacci, Sterling and Bell sequences), principle of inclusion and exclusion, and an introduction to the theory of graphs. Applications will be indicated. Offered periodically. Prereq: C- or higher in MATH 322.

MATH 400: 3-12 s.h.**Co-Op Ed Experience in Math**

Co-Op Ed Experience in Math

MATH 405: 3 s.h.**Teaching Math in Secondary Schools 2**

The second of two secondary mathematics methods courses, participants will focus on: lesson planning, unit development, and implementation; assessment and evaluation; classroom management and organization within school communities; and continued professional growth as reflective practitioners. A considerable portion of class time will be devoted to teaching mathematics to secondary school students. Must be taken simultaneously with EDSE 321, EDSE 340, SPED 346. Offered fall. Prereq/Co-requisite: C- or higher in MATH 305. Prereq: C- or higher in MATH 325, MATH 333 (or 335/435), MATH 345, and MATH 354.

MATH 408: 1-3 s.h.**Topics in Mathematics**

Topics in Mathematics. Topics courses are scheduled by arrangement with the instructor; semester hours of credit and meeting times for those courses are set by agreement.

MATH 418: 1-3 s.h.**Topics in Math Education**

Topics in Mathematics Education. Topics courses are scheduled by arrangement with the instructor; semester hours of credit and meeting times for those courses are set by agreement.

MATH 419: 1 s.h.**Actuarial Science Seminar**

A synthesis of calculus and probability that will develop the knowledge of the fundamental probability tools for quantitatively assessing risk. Students will be provided with the skills required in such examinations as the SOA Exam P and CAS Exam 1. Does not count as an upper-division elective for the mathematics major or minor. Offered in spring.

MATH 422: 3 s.h.**Linear Algebra 2**

A continuation of MATH 322. Topics include further theory of linear transformations and their matrix representations: invariant subspaces, equivalent and similar matrices, canonical forms. The vector space $L(V, W)$. Orthogonal transformations and isometries; analysis of Euclidean motions in R^3 . Least squares approximation and theory of generalized inverses. Bilinear and quadratic forms and their matrix representations; applications to conic sections in R^2 and quadric surfaces in R^3 . Complex vector spaces. Offered periodically. Prereq: MATH 310 and C- or higher in MATH 322.

MATH 435: 3 s.h.**Mathematical Statistics 2**

A continuation of MATH 335. Functions of random variables, sampling distributions, point estimation, interval estimation, hypotheses-testing theory and applications. Offered in spring. Prereq: C- or higher in MATH 335.

MATH 435H: 3 s.h.**HNRS:Mathematical Stats 2****MATH 438: 1-3 s.h.****Topics in Statistics**

Topics in Statistics. Topics courses are scheduled by arrangement with the instructor; semester hours of credit and meeting times for those courses are set by agreement.

MATH 445: 3 s.h.**Abstract Algebra 2**

Continuation of MATH 345. Introduction to field theory, rings of polynomials, introduction to Galois theory. Offered periodically. Prereq: C- or higher in MATH 345.

MATH 457: 3 s.h.**Elementary Differential Geometry**

Frenet frames; curvature and torsion of curves in 3-space. Calculus of vector fields; geodesics and curvature of surfaces in 3-space. Surface area and volume. The Euler characteristic of a surface and the Gauss-Bonnet theorem. Rigid motions and isometries. Riemannian metrics, parallelism, non-Euclidean geometries and applications. Offered periodically. Prereq: C- or higher in MATH 310, 311, 322.

MATH 464: 3 s.h.**Real Analysis 1**

Rigorous development of the concepts and methods of calculus. The real number system and its topology; theory of limits and continuity; differentiable functions and their properties, the Riemann integral. Prereq: C- or higher in MATH 311 and MATH 345 or department permission.

MATH 464H: 3 s.h.**Hnrs: Real Analysis 1**

MATH 465: 3 s.h.**Real Analysis 2**

Continuation of MATH 464. Topics chosen from the following: convergence and uniform convergence of infinite sequences and series of functions; topology of Euclidean n -space \mathbb{R}^n ; differential calculus of functions $\mathbb{R} \rightarrow \mathbb{R}$ and $\mathbb{R}^n \rightarrow \mathbb{R}^m$; extreme values; implicit and inverse function theorems; Riemann integration in \mathbb{R}^n ; metric spaces; function spaces; Riemann-Stieltjes integration. Offered infrequently. Prereq: C- or higher in MATH 464.

MATH 467: 3 s.h.**Partial Differential Equations**

Fourier series and the method of separation of variables; the wave equation, heat equation and Laplace's equation; d'Alembert's formula. Maximum principles, energy integrals and uniqueness. Sturm-Liouville problems and eigenfunction expansions. Offered in fall. Prereq: C- or higher in MATH 365.

MATH 471: 3 s.h.**Mathematical Modeling**

Applications of mathematics to real-world problems drawn from industry, research laboratories, the physical sciences, and engineering and the scientific literature. May include parameter estimation, curve fitting, elementary probability, optimization, computer programming, and ordinary and partial differential equations. Offered periodically. Prereq: C- or higher in MATH 365.

MATH 472: 3 s.h.**Financial Mathematics II**

Develops knowledge of the theoretical basis of actuarial models and the application of those models to insurance and other financial risks. Pricing formulas for forwards, futures, and options are developed and used in financial strategies designed to reduce risk. Prereq: C- or better in MATH 335 or MATH 333 and C- or better in MATH 372.

MATH 478: 1-3 s.h.**Topics in Applied Mathematics**

Topics in Applied Mathematics. Topics courses are scheduled by arrangement with the instructor; semester hours of credit and meeting times for those courses are set by agreement.

MATH 479: 3 s.h.**Experimental**

Experimental

MATH 483: 3 s.h.**Point-Set Topology**

Foundation course for extensive study in modern higher analysis, topology and related areas. Infinite set theory, metric spaces, topological spaces, separation properties, continuous mappings, homeomorphisms, convergence theory, product spaces, quotient spaces, connectedness, compactness, function spaces, applications. Offered infrequently. Prereq: C- or higher in MATH 464 or permission of instructor.

MATH 489: 1-4 s.h.**Honors Course**

For the definition of honors course/thesis and eligibility, refer to the Special Academic Opportunities section of this catalog.

MATH 498: 1-3 s.h.**Independent Study**

For further information on independent study, see the Special Academic Opportunities section.

MATH 499: 1-12 s.h.**Departmental Honors (AW)**

For the definition of honors course/thesis and eligibility, refer to the Special Academic Opportunities section of this catalog.

MATH 500: 3-12 s.h.**Co-Op Ed Experience in Math**

Co-Op Ed Experience in Math

MATH 502: 4 s.h.**Linear Algebra**

Systems of linear equations, matrix algebra and determinants; real vector spaces, linear independence, basis and dimension; real inner product spaces, Gram-Schmidt orthogonalization; eigen theory and diagonalization; linear transformations and matrix representation. Prereq or Coreq: MATH 311; MATH 310/520 recommended.

MATH 503: 4 s.h.**Probability and Stats for Tchrs**

A rigorous one-semester study of probability, distribution theory and the basics of statistical inference. Topics include probability, expectation, discrete and continuous distributions, descriptive statistics and both estimation and hypothesis testing for one- and two-sample problems. Prereq: MATH 311.

MATH 504: 3 s.h.**Modern Algebra for Teachers**

Algebraic properties of complex number systems, set theory, groups, rings, integral domains and fields. MATH 310/520 and MATH 322/502.

MATH 505: 4 s.h.**Classical & Modern Geometry**

Study of geometry from both classical and transformational points of view. The classical part will focus on the axiomatic development of various forms of geometry; the transformational part will focus on the study of geometry in terms of two families of transformations: isometries and similarities. Emphasis on investigating geometry using both classical and transformational approaches and their interactions.

MATH 506: 3 s.h.**Modern Analysis for Teachers**

Real number system, limits of sequences and functions, theory of differentiation, Riemann integration, infinite series. Prereq: MATH 310/520, 311, 322/502. MATH 345/504 recommended.

MATH 520: 3 s.h.**Logic and Foundations of Math**

Theory of inference, symbolic logic, nature of axiom systems, validity of proofs, consistency, independence, completeness, theory of sets and cardinal numbers.

MATH 535: 3 s.h.**Statistical Methods 1**

Survey of statistical methods used in research, education, behavioral science and biomedical applications. Experimental designs discussed regarding advantages, disadvantages, sampling problems and analysis. Regression and analysis of variance. Prereq: An elementary probability or statistics course. Offered in fall and periodically in summer.

MATH 536: 3 s.h.**Statistical Methods 2**

Continuation and extension of statistical methods introduced in Statistical Methods I (Math 535). Advanced topics in analysis of variance, randomized block designs and experimental designs. Prereq: Math 535 or permission of instructor. Offered in spring.

MATH 536H: 3 s.h.**Hon: Statistical Methods II**

MATH 537: 1 s.h.**Statistical Problem Solving Seminar**

Capstone course designed to serve as outcome assessment for math majors enrolled in statistics option. Course involves problem solving, data analysis and statistical consulting. Materials drawn from real-world problems. Prereq: Math 535. Coreq: Math 536. Offered in spring.

MATH 566: 3 s.h.**Complex Variables**

Complex number system, analytic functions, elementary functions, contour integration, residues and poles, conformal mapping. Prereq: MATH 506 or equivalent. Offered infrequently.

MATH 577: 3 s.h.**Problems in Applied Math**

An investigation of one or more topics of current interest in applied mathematics. Specific topics to be covered vary but are announced each time the course is offered. Offered infrequently.

MATH 592: 3 s.h.**Graph Theory**

Finite graphs, multigraphs, digraphs and networks from theoretical, practical and historical perspectives. Specific topics include isomorphisms, graph variants, planarity and nonplanarity, traversability, colorings, flows, matchings and optimization algorithms. Prereq: MATH 502 or equivalent. Offered periodically.

MATH 592H: 3 s.h.**HNRS: Graph Theory****MATH 602: 3 s.h.****Equity Issues in Math Ed**

Designed for graduate level students with an interest in equity issues in mathematics education. In this course, we examine issues of equity in mathematics education from various theoretical and practical perspectives and long lines of race, gender, culture and socioeconomic status. It is a reading-intensive course that spans such topics as the achievement gap, tracking, culturally-relevant pedagogy, multiculturalism, the nature of mathematics and mathematics for democracy and social justice. Course assignments will be differentiated to ensure they are relevant to the concerns of both practicing teachers as well as students without a teaching background that intend to pursue further graduate study.

MATH 603: 3 s.h.**History of Mathematics**

Evolution of mathematical concepts from antiquity to the present century. Emphasis on eras of great mathematical activity.

MATH 604: 3 s.h.**Ethnomathematics**

This course aims to introduce Ethnomathematics as a field by examining mathematics across and within cultures. In addition, the course is designed to strengthen and expand students' understanding of mathematical topics (e.g., number systems, geometry, combinatorics, group theory) through study of the mathematics of world cultures. Furthermore, students will discuss ways in what is done in the course may be used to refresh or augment 7-12 school mathematics courses and develop school materials in Ethnomathematics.

MATH 606: 3 s.h.**Noyce - Transitioning**

Intended to address topics and concerns relevant to recently-certified NOYCE secondary mathematics teachers as they transition to their first year of teaching in a high-needs school district. Through readings, class discussions, individual presentations, and written assignments, participants reflect on their student teaching experiences, further explore challenges of working with diverse groups of students, and develop strategies to increase their effectiveness as a teacher in the context of a high-needs district. Instructor Permission required.

MATH 607: 3 s.h.**Noyce - Moving to Tenure**

Intended as an extension to MATH 606 and meant to address topics and concerns relevant to recently-certified NOYCE secondary mathematics teachers as they complete their first year of teaching in a high-needs school district. Through readings, class discussions, individual presentations, and written assignments, participants reflect on their experiences during the first year of teaching, further explore challenges of working with diverse groups of students, and develop strategies to increase their effectiveness as a teacher in the context of a high-needs district. Instructor Permission required.

MATH 610: 3 s.h.**Problem Solving Seminar**

Develops students' problem-solving abilities in mathematics and teaching of problem solving to high school students. Includes discussion of solutions to problems and the theories of problem solving. For both teachers and nonteachers. Offered periodically.

MATH 611: 3 s.h.**Learning Mathematics**

Investigation of the learning theory of constructivism and its application to the learning of mathematics. Emphasis on higher-order concept acquisition and schema development, and their relationship to mathematical instruction and teacher decision making. Individual differences in learning styles are also discussed. Prereq: teaching experience or permission of the instructor. Offered periodically.

MATH 613: 3 s.h.**Elem/Sec Math Connections**

This course is designed for graduate level students and will be of particular interest to practicing mathematics teachers of grades 7-12. In this course, we will explore the foundational concepts of the K-6 mathematics curriculum in significant depth while reflecting on ways to build strong connections between this elementary content and the content in the 7-12 curriculum. The goal is for students to see where their own teaching fits in the broader scheme of K-12 mathematics education so that they can design instruction that builds on their own students' prior understanding and contributes to a more holistic development for mid-level, middle, and high school mathematics learners. Course assignments may involve presentations, discussions, reading, written exams, papers, problem solving, problem posing, and instructional design.

MATH 614: 3 s.h.**Current Issues in Middle Sch**

Current issues relating to middle school mathematics instruction, including issues associated with teaching strategies as well as curricular issues. Central to this discussion will be the NCTM's Principles and Standards for School Mathematics and the PA Academic Standards for Mathematics. Prereq: teaching experience or permission of the instructor. Offered periodically.

MATH 615: 3 s.h.**Current Issues in Secndry Schl**

Current issues relating to secondary school mathematics instruction, including issues associated with teaching strategies as well as curricular issues. Central to this discussion will be the NCTM's Principles and Standards for School Mathematics and the PA Academic Standards for Mathematics. Prereq: teaching experience or permission of the instructor. Offered periodically.

MATH 617: 3 s.h.**Middle/Secdry Schl Innovatns**

Current curricular issues and teaching strategies associated with educational innovations that are invariant with respect to the middle school-secondary school boundary. Central to this discussion will be the NCTM's Principles and Standards for School Mathematics and the PA Academic Standards for Mathematics. Prereq: teaching experience or permission of the instructor. Offered periodically

MATH 618: 3 s.h.**7-12 Assessment**

Course for secondary mathematics teachers who wish to explore the nature of the mathematics assessment from a variety of perspectives. The course will examine traditional and non-traditional forms to assessment as well as the purpose of formative and summative assessments - allowing for discussion of the pros and cons to each. The course will also examine the impact of assessment tools on individual classroom instruction as well as within local departments, schools, districts, states and national education issues. The course will seek to actively involve teachers in a productive dialogue about the mathematics that they teach and explore a variety of levels at which the mathematics can be assessed. In order to do this, it will be necessary at times to expand and explore K-16 mathematics assessment at some length.

MATH 619: 3 s.h.**Advanced Perspectives**

Course is for secondary mathematics teachers at the middle or high school level who wish to explore the nature of the mathematics that they teach from a different viewpoint. The course will look at typical secondary mathematics topics including the real number system, polynomials, number theory, trigonometry and Euclidean geometry while examining concept analysis, problem analysis and mathematical connections. The course will actively involve in-service and pre-service teachers in a productive dialogue about the mathematics that they teach, and potential developmental or extensions that could be put into practice at each level. The class will also explore a variety of levels at which it may be appropriate to address these issues with their own students.

MATH 622: 3 s.h.**21st Century Math**

The intent of the course, Teaching Mathematics in The 21st Century, is to examine, study, and analyze teaching techniques and alternate approaches to teaching and learning mathematics in the 21st century. Students will experiment with a variety of pedagogies that are more in-line with the way in which 21st century students live rather than how they are often taught. Comparisons of multiple pedagogies (current, past and potential future) will be frequently made and discussed.

MATH 642: 3 s.h.**Linear Algebra**

Vector spaces, linear transformations, matrices, systems of equations, determinants. Prereq: MATH 502 or equivalent. Offered infrequently.

MATH 650: 3 s.h.**Topics in Geometry**

Topics selected from the parallel postulate and models for Euclidean and non-Euclidean geometries; projective geometry; local geometry of smooth space curves; geometry of smooth surfaces in space; geometry of space-time; finite geometries; representation of a geometry as a group of transformations acting on a set. Prereq: teaching experience or permission of instructor. Offered infrequently.

MATH 670: 3 s.h.**Operations Research**

Principles of model building; examples from linear optimization, network analysis, dynamic programming, probabilistic decision theory, Markov chains, queuing theory, simulation and inventory models. Applications and theory. Prereq: MATH 642 or equivalent, and a statistics course or equivalent. Offered periodically.

MATH 672: 3 s.h.**Math Modeling in Secondary Sch**

of the process of mathematical modeling. Creative and empirical model construction, model analysis and model research. Problems taken from a variety of disciplines. Some problems suitable for algebra and geometry students; others require some knowledge of calculus and statistics. Prereq: MATH 502 or its equivalent. Offered periodically.

MATH 675: 3 s.h.**Numerical Analysis**

Numerical treatment of equations, matrices and systems of equations; interpolation and approximation by polynomials; numerical integration; method of least squares. Prereq: MATH 502 and MATH 506, or equivalent. Offered in fall.

MATH 679: 3 s.h.**Technol in Secondary Schl Math**

Introduction to technologies currently available for teaching secondary mathematics. Emphasis on the use of modern graphics calculators, although computer software is also presented. Capabilities of the technologies examined in depth, but emphasis will be on the use of this technology in the classroom. Mathematical topics selected from elementary algebra, geometry, algebra II, precalculus and calculus. Prereq: secondary teaching experience. Offered periodically.

MATH 683: 3 s.h.**General Topology**

Set theory, metric and topological spaces, cluster points, closure, interior and boundary, continuity, homeomorphisms, product and quotient spaces, separation, compactness, connectedness, completeness. Prereq: MATH 502, 504 and 506.

MATH 691: 3 s.h.**Combinatorics**

Counting techniques including the multiplication principle, the addition principle, the pigeon-hole principle, permutations, combinations, the principle of inclusion-exclusion, recurrence relations, generating functions and Polya's Theory of Enumeration. Prereq: MATH 502 or equivalent. Offered periodically.

MATH 693: 3 s.h.**Number Theory**

The classic higher arithmetic of integers: mathematical induction, divisibility, congruences, prime numbers, diophantine equations. Euler-Fermat Theorem and quadratic reciprocity. Offered periodically.

MATH 695: 3 s.h.**Topics in Mathematics**

Investigation of one or more mathematical topics of current interest not covered in regular courses. Topics and methods of instruction may vary according to the needs and interests of students and faculty involved. Offered infrequently.

MATH 696: 1-3 s.h.**Independent Study**

Selected topics. Prereq: permission of chairperson. Offered infrequently.

MATH 697: 1-3 s.h.**Topics in Math Education**

Investigation of one or more topics of current concern in mathematics education not covered in regular courses. Course content varies according to the needs and interests of students and faculty involved. Offered infrequently.

MATH 698: 1-3 s.h.**Independent Study**

Selected topics. Offered infrequently.

MATH 699: 3-6 s.h.**Thesis:**

Thesis