MATHEMATICS

The Department of Mathematics offers three baccalaureate-degree programs with a major in mathematics. It also offers minors in mathematics and statistics.

The recommended course sequences in the three mathematics programs are virtually identical through the first two years. The Bachelor of Arts (B.A.) degree program in mathematics is a flexible curriculum designed to accommodate the widest possible range of career objectives. It is structured according to the traditional liberal arts approach to college education. The second semester of a foreign language is required in the B.A. program. The Bachelor of Science (B.S.) degree program is more specifically applications oriented. With more required courses in mathematical analysis and science, it is somewhat less flexible than the B.A. program. The Bachelor of Science in Education (B.S.Ed.) degree program is the degree and certification degree program for prospective secondary teachers of mathematics. In addition to having mathematics course requirements comparable to those of the two other programs, the B.S.Ed. requires appropriate educational methods courses.

Mathematics majors may elect an option in actuarial science, applied mathematics or statistics designed to prepare students for careers in these applied fields.

For admission as a major in mathematics, a student is expected to have a sound preparation in high school academic mathematics: algebra I and II, plane geometry and precalculus (trigonometry and analytic geometry). Such students normally begin their mathematics sequence with Calculus I. Students who have completed a calculus course in high school are encouraged to take the College Board Advanced Placement Exam and have their score sent to Millersville University for evaluation. University credit for first year-level mathematics courses may be offered to students with scores of 3 or higher. For further information, see Advanced Placement Examinations in the Admissions section.

In an effort to ensure that each student is properly placed, the department administers mathematics placement assessments. For more information, see the Academic Requirements: Proficiency Requirements section.

The cooperative education program allows students valuable experience in a full-time or part-time professional position related to their career goals, adding practical relevance to their program of study as well as significant financial remuneration. This often leads to full-time employment after graduation. Students may elect one or more cooperative education experiences.

the programs


the faculty

Buchanan, J. Robert; Professor
College of Science and Technology
B.S., Davidson College, 1983; M.S., North Carolina State University, 1985; Ph.D., Ibid., 1993

Cardwell, Antonia; Associate Professor
College of Science and Technology
B.S., University of the Witwatersrand (Johannesburg), 1998; M.A., Kent State University, 2001; Ph.D., Ibid., 2005

Dever, Lindsay; Assistant Professor
College of Science and Technology
B.S., The College of New Jersey, 2015; M.A., Bryn Mawr College, 2019; Ph.D., Bryn Mawr College, 2022

Fenwick, James; Professor
College of Science and Technology
B.S., Clarion State College, 1980; M.S., University of Vermont, 1983; Ph.D., University of Wyoming, 1985

Garber, Diana; Instructor
College of Science and Technology
B.A., Millersville University, 1991; M.Ed., Ibid., 1997

Han, Zhigang; Associate Professor
College of Science and Technology
B.A., Fudan University (China), 1997; Ph.D., Stony Brook University, 2006

Heitmann, Noel; Associate Professor
College of Science and Technology
B.S., The Pennsylvania State University, 1989; B.S., University of Pittsburgh, 1996; M.A., Ibid., 1998; Ph.D., Ibid., 2003

Ma, Baoling; Associate Professor
Mathematics

College of Science and Technology
B.S., Ocean University of China, 2007; Ph.D., University of Louisiana-Lafayette, 2012.

Moss, Erin; Professor
College of Science and Technology
B.A., University of North Carolina at Asheville, 2001; M.S., University of Connecticut, 2003; Ph.D., Purdue University, 2009.

Robinson, Kevin; Associate Professor
College of Science and Technology
B.A., Messiah College, 1993; M.S., University of Florida, 1995; Ph.D., Ibid., 2000

Schultz, Delray; Professor
College of Science and Technology
B.S., Moravian College, 1977; M.A., The Pennsylvania State University, 1980; Ph.D., Temple University, 1992

Stewart, Patrick; Assistant Professor
College of Science and Technology
B.S., Marshall University, 2011; M.A., Ibid., 2014; M.S., Virginia Polytechnic Institute and State University, 2015; Ph.D., Bowling Green State University, 2020

Taylor, Cynthia; Professor
College of Science and Technology
B.S., Indiana University of Pennsylvania, 1988; M.S., Rensselaer Polytechnic Institute, 2002; Ph.D., University of Missouri, 2011

Washington, H. Tyrone; Associate Professor
College of Science and Technology
B.S., Fayetteville State University, 1998; M.S., North Carolina State University, 2001; Ph.D., Ibid., 2012

White, Janet; Professor
College of Science and Technology
B.A., Grove City College, 1988; M.Ed., Millersville University, 1994; Ph.D., American University, 2002

Wismer, Michael; Assistant Professor
College of Science and Technology
B.A., Messiah College, 1987; M.A., West Chester University, 1991; Ph.D., University of Delaware, 1997

Zhan, Mingquan; Professor
College of Science and Technology
B.S., Nanjing Normal University, 1990; M.S., Ibid., 1997; Ph.D., West Virginia University, 2003

The courses

MATH 101: 3 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 103: 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 104: 3 s.h.
Fundamentals of Math 2 (G2)
An extension of MATH 103; 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 105: 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 School of Science and Mathematics 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.
Algebraic Foundations for Mid-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 grade of C or better in MATH 104 or department permission. For middle-level education majors only.

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 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.

MATH 279: 1-4 s.h.
Experimental

MATH 300: 3-12 s.h.
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.
Hrs: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 301H: 3 s.h.
Hon: Intro to Mathematic Proof (W)
MATH 311: 4 s.h.
Calculation 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 utilize 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 Prob
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 Rn, 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. Offered in fall. 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. Offered in spring and periodically in summer. 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

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 R3. Least squares approximation and theory of generalized inverses. Bilinear and quadratic forms and their matrix representations; applications to conic sections in R2 and quadric surfaces in R3. 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 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 R^n; differential calculus of functions R^n->R^n; extreme values; implicit and inverse function theorems; Riemann integration in 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.
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

RETENTION IN THE MAJOR POLICY
University requirements for retention must be met. A mathematics major taking any course required as a prerequisite for a later mathematics course must earn a grade of C- or higher in that course before taking the later course for which it is a prerequisite.