MATHEMATICS
Hibbard Humanities Hall 508
715-836-3301

Mathematics has formed an important part of our intellectual heritage for centuries. In addition to having its own aesthetic value, it pervades a growing number of human endeavors. Mathematics is applied in fields as diverse as business, engineering, the physical and life sciences, the social sciences, computer science, and the fine arts. Society therefore expects of its members ever increasing mathematical knowledge and skill.

The mathematics curriculum is designed to address these needs. It provides a core of fundamental mathematics as well as a variety of electives for individuals with specific interests. Students may select programs to prepare for careers in applied mathematics, science, actuarial science, research, mathematics education, or for graduate study. Regardless of emphasis, the programs prepare students for their immediate career objectives and provide a background that will enable them to cope with changing career needs and goals.

Information for All Students
1. All entering freshmen and transfer students must take the mathematics placement test.
2. A student may not register for credit in a course which is a prerequisite for any other course in which the student has credit.
3. It is strongly recommended that a grade of C or above is achieved in any mathematics course that is to be used as a prerequisite to another course.

Department Honors in Mathematics
The Honors Program in mathematics is intended for mathematics majors—including actuarial science, mathematics education, and liberal arts majors—who have demonstrated excellence in their coursework, and who want to experience the mathematical community outside the classroom. The high impact practices required for department honors in mathematics align with such experiences.

- **Eligibility**: Mathematics majors who have a resident and total GPA of 3.50 or higher, and have completed at least 12 hours of mathematics courses with a GPA of 3.50 or higher.
- **Application**: An application (which is available in the mathematics department office) must be submitted to the department chair with a letter of support from a mathematics faculty member. The application should be submitted during the junior year.
- **Requirements**: Graduate with a 3.50 GPA or higher in the major, and submit evidence to the department chair that two of the following have been satisfactorily completed:
  1. A faculty/student collaborative mathematics research project
  2. Score of 176 or above on the ETS Mathematics Content Knowledge assessment (Praxis II)
  3. An off-campus mathematics presentation at a conference
  4. Participation in a state, regional or national competition in Actuarial Science
  5. Passing grade on two professional exams given by the Society of Actuaries or Casualty Actuarial Society

  6. A mathematics related internship
  7. Acceptance of a mathematics publication in a peer-reviewed journal.

Faculty
Alexander Smith, Chair

- Chris Ahrendt
- Silviana Amethyst
- Mohammad Aziz
- Allison Beemer
- Abra Brisbin
- Christopher Davis
- Herschel Day
- Colleen Duffy
- Marc Goulet
- Jennifer Harrison
- Ryan Harrison
- Christopher Hlas
- Marie-Claire Koissi-Kouassi
- Jessica Kraker
- aBa Mbirika
- Carolyn Otto
- Kristopher Presler
- Katrina Rothrock
- Sam Scholze
- Feroz Siddique
- Andrew Swanson
- Wufeng Tian
- Melissa Trott
- Shanise Walker
- Mckenzie West
- Vicki Whittle

Majors
- **Comprehensive Major**: Actuarial Science, Liberal Arts - B.A./B.S. ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/actuarial-science-comprehensive-major-ba-bs/))
- **Major**: Mathematics, Liberal Arts Emphasis - B.A./B.S. ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-major-liberal-arts-ba-bs/))
- **Comprehensive Major**: Mathematics, Research Emphasis, Liberal Arts - B.A./B.S. ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-comprehensive-major-research-ba-bs/))
- **Major**: Mathematics, Statistics and Applied Mathematics Emphasis, Liberal Arts - B.A./B.S. ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-major-statistics-applied-mathematics-ba-bs/))
- **Major**: Mathematics, Teaching - B.S. ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-major-teaching-bs/))
- **Comprehensive Major**: Mathematics, Teaching - B.S. ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-comprehensive-major-teaching-bs/))

Minors
- **Minor**: Mathematics, Liberal Arts ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-minor/))
- **Minor**: Mathematics, Actuarial Science ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-actuarial-science-minor/))
- **Minor**: Mathematics, Teaching ([link](http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/mathematics-minor-t/))
• Minor: Mathematics, Middle Childhood/Early Adolescence, Teaching
  (http://catalog.uwec.edu/undergraduate/arts-sciences/mathematics/
  mathematics-minor-mceat/)

Data Science (DS)

DS 700 Foundations of Data Science (3 crs)
Prerequisite: Limited to Data Science master’s degree students.
Introduction to data science and its importance in business decision making.
Attributes: Data Science MS OL Flat Rate Tuition, Special Course Fee Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

DS 705 Statistical Methods (3 crs)
Prerequisite: Limited to Data Science master’s degree students.
Statistical methods and inference procedures presented with an emphasis on
applications, computer implementation, and interpretation of results.
Attributes: Data Science MS OL Flat Rate Tuition, Special Course Fee Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

DS 710 Programming for Data Science (3 crs)
Prerequisite: Limited to Data Science master’s degree students.
Introduction to programming languages and packages used in data science.
Attributes: Data Science MS OL Flat Rate Tuition, Special Course Fee Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

DS 715 Data Warehousing (3 crs)
Prerequisite: Limited to Data Science master’s degree students.
Introduction to the concepts and techniques to work with and reason about
subject-oriented, integrated, time-variant, and nonvolatile collections of data in
support of management’s decision-making process.
Attributes: Data Science MS OL Flat Rate Tuition, Special Course Fee Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

DS 730 Big Data: High Performance Computing (3 crs)
Prerequisite: Limited to Data Science master’s degree students.
Overview of how to process large datasets efficiently, including introduction of
non-relational databases.
Attributes: Data Science MS OL Flat Rate Tuition, Special Course Fee Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
DS 785 Data Science Capstone (3 crs)
Prerequisite: Limited to Data Science master’s degree students.
- Full-time equivalent.
Capstone course; students will develop and execute a data science project using real-world data and communicate results to a non-technical audience.
Attributes: Data Science MS OL Flat Rate Tuition, Special Course Fee Required
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

Mathematics (MATH)

MATH 10 Basic Mathematics and Elementary Algebra (4 crs)
Prerequisite: For students with minimal high school mathematics or appropriate score on the mathematics placement test.
- No credit if taken after credit is earned in any higher-numbered mathematics course. This course is graded on a letter grade basis. The grade received is used in calculating semester, resident, and total GPAs.
Develops basic mathematics and elementary algebraic skills necessary for further study of algebra.
Grading Basis: No Auditors
Lecture/Discussion Hours: 1
Lab/Studio Hours: 3

MATH 20 Intermediate Algebra (4 crs)
Prerequisite: A grade of C or above in MATH 10, or one year of college-preparatory algebra and an appropriate score on the mathematics placement test.
- This course is graded on a letter grade basis. The grade received is used in calculating semester, resident, and total GPAs. No credit if taken after credit is earned in any higher-numbered mathematics course except MATH 106 or MATH 107.
The real number system, linear equations and inequalities, operations on polynomials and rational expressions, factoring, solutions of quadratic equations, Cartesian coordinates, functions, and related applications.
Grading Basis: No Auditors
Lecture/Discussion Hours: 1
Lab/Studio Hours: 3

MATH 50 Supplemental Math Preparation (1 cr)
Prerequisite: Suitable mathematics placement test score and concurrent enrollment with MATH 104, 108, 109, 201 or 246.
Development of foundational skills and concepts to allow concurrent enrollment in certain credit-bearing mathematics courses in lieu of prerequisite enrollment in MATH 20.
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 1
Lab/Studio Hours: 0

MATH 104 Finite Mathematics with Applications (4 crs)
Prerequisite: Grade of C or above in MATH 20, or 2 yrs college-prep algebra + suitable math placement score, or concurrent enrollment in MATH 50 + suitable placement score, or grade of C or above in MATH 50. No credit after MATH 114, 212, 314 or 346
- May not be counted for credit toward a major or minor in mathematics.
This course will cover applications from Economics, Social and Biological Sciences. The topics include sets, functions, counting principles, probability, solutions of linear systems by graphical and algebraic methods, matrices, linear programming, problem formulation, and using graphs and trees.
Attributes: GE IB Communication-Analytical Skills, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 106 Introduction to Mathematical Thinking (4 crs)
Prerequisite: MATH 20, or two years of college-preparatory algebra and a suitable mathematics placement test score. Credit may not be earned in both MATH 106 and MATH 101.
- May not be counted for credit toward a major or minor in mathematics.
An accessible introduction to some interesting mathematical topics that require analytical thinking and abstract reasoning skills.
Attributes: GE IB Communication-Analytical Skills, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 107 Mathematics in Latin American Cultures (4 crs)
Prerequisite: MATH 20, or two years of college-preparatory algebra and a suitable mathematics placement test score.
- May not be counted for credit toward a major or minor in mathematics.
This course introduces important mathematical concepts and topics, such as number and arithmetic systems, symmetry, and data structure, using the cultural lenses of pre-Columbian Latin American indigenous cultures.
Attributes: GE IB Communication-Analytical Skills, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 108 Earth Algebra (4 crs)
Prerequisite: Grade of C or above in MATH 20, or 2 yrs college-prep algebra + suitable math placement score, or concurrent enrollment in MATH 50 + suitable placement score, or grade of C or above in MATH 50.
- May not be counted for credit toward a major or minor in mathematics.
Modeling real data drawn from biology, the environment, finance, and other physical systems. Topics include the development of linear, polynomial, exponential and logarithmic functions, and the rate of change in an applied setting.
Attributes: GE IB Communication-Analytical Skills, LE-R3 Civic and Environmental Issues, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0
MATH 109 Algebra for Calculus (4 crs)
Prerequisite: Grade of C or above in MATH 20, or 2 yrs college-prep algebra + suitable math placement score, or concurrent enrollment in MATH 50 + suitable placement score, or grade of C or above in MATH 50.
  • May not be counted for credit toward a major or minor in mathematics.

Algebraic concepts, techniques, and applications including polynomial and rational expressions, linear and quadratic equations, complex numbers, inequalities, absolute value, functions and graphs, exponential and logarithmic functions, systems of equations and inequalities, and zeros of polynomials. This course is for students pursuing degree programs that require calculus.

Attributes: LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 111 A Short Course in Calculus (4 crs)
Prerequisite: MATH 109, or a grade of B or above in MATH 108, or three years of above-average work in college-prep MATH and a suitable mathematics placement test score.
  • May not be counted for credit toward a major or minor in mathematics.

Primarily for students in biology, business, economics, psychology, and sociology. Functions, limits, continuity, derivatives, integrals, and applications.

Attributes: GE IB Communication-Analytical Skills, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 112 Precalculus Mathematics (4 crs)
Prerequisite: MATH 108, or MATH 109, or three years of above-average work in college-prep MATH and a suitable mathematics placement test score.
  • May not be counted for credit toward a major or minor in mathematics.

Prepares students to enter the Math 114, Math 215, Math 216 sequence. Includes absolute value; logarithmic, exponential, and trigonometric functions; inequalities; conic sections; complex numbers; and topics from theory of equations.

Attributes: LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 113 Trigonometry (2 crs)
Prerequisite: MATH 109, or a grade of B or above in MATH 108, or three years of above-average work in college-prep MATH and a suitable mathematics placement test score. Credit may not be earned in both MATH 113 and MATH 112.
  • May not be counted for credit toward a major or minor in mathematics.

Graphs, properties, and geometric significance of trigonometric functions of a real variable. Other topics include trigonometric equations and identities, inverse trigonometric functions and applications.

Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MATH 114 Calculus I (4 crs)
Prerequisite: MATH 109 and MATH 113, or MATH 112, or four years of above-average work in college-prep mathematics, including one semester of trigonometry and a suitable mathematics placement test score.

Limits, theory, and application of the derivative; introduction to integration.

Attributes: GE IB Communication-Analytical Skills, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 150 Introduction to the Actuarial Career (1 cr)
  • No credit if take after Math 291 when offered as Introduction to the Actuarial Career

Designed to start or further efforts in understanding the actuarial profession and to prepare students for an actuarial job search.

Lecture/Discussion Hours: 0
Lab/Studio Hours: 3

MATH 201 Number and Operations I (2 crs)
Prerequisite: Grade of C or above in MATH 20, or 2 yrs college-prep algebra + suitable math placement score, or concurrent enrollment in MATH 50 + suitable placement score, or grade of C or above in MATH 50. ELED and SPED majors/minors only.

Mathematical knowledge for teachers based on practice/content standards. Topics include: number systems, number theory, and integer algorithms.

Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MATH 202 Number and Operations II (2 crs)
Prerequisite: MATH 201. Limited to elementary and special education majors and minors.

Mathematical knowledge for teachers based on practice/content standards. Topics include: fractions, ratios/proportions, and decimals.

Attributes: LE-S2 Mathematics
Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MATH 203 Mathematics for Elementary/Middle School Teachers I (3 crs)
Prerequisite: A grade of C or above in MATH 20, or two years of college-preparatory algebra and a suitable mathematics placement test score. Limited to elementary or special education majors and minors.
  • May not be counted for credit toward a major or minor in mathematics.

An integrated study of mathematics content, methods, and curricula. Topics include problem solving, reasoning, whole numbers and numeration with an emphasis on cognitively guided instruction, elementary number theory, integers.

Attributes: GE IB Communication-Analytical Skills
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
MATH 204 Mathematics for Elementary/Middle School Teachers II (3 crs)
Prerequisite: MATH 203. Limited to elementary and special education majors and minors. Minimum sophomore standing.
- Counts only toward the elementary teaching minor in mathematics.

An integrated study of mathematics content, methods, and curricula. Topics include number theory, the rational numbers, ratio and proportion, the real number system and probability. Emphasis on communication and algebraic thinking. Practicum experience included.

Attributes: GE IB Communication-Analytical Skills
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 212 Calculus and Business Mathematics (3 crs)
Prerequisite: MATH 111 or MATH 114.
- May not be counted toward a major in mathematics.

Multivariate calculus, matrix algebra, linear programming, mathematics of finance, and business-oriented applications.

Attributes: GE IB Communication-Analytical Skills
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 215 Calculus II (4 crs)
Prerequisite: MATH 114

Applications and techniques of integration; improper integrals; sequences and series; power series and Taylor's formula.

Attributes: GE IB Communication-Analytical Skills
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 216 Calculus III (4 crs)
Prerequisite: MATH 215

Introduction to functions of several variables, including partial derivatives, multiple integrals, the calculus of vector-valued functions, and Green's Theorem, Stokes' Theorem, and the Divergence Theorem.

Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 246 Elementary Statistics (4 crs)
Prerequisite: Grade of C or above in MATH 20, or 2 yrs college-prep algebra + suitable math placement score, or concurrent enrollment in MATH 50 + suitable placement score, or grade of C or above in MATH 50.
- May not be counted for credit toward a major or minor in mathematics with the exception of the Middle Childhood/Early Adolescence minor in mathematics.

Basic statistical analysis, including descriptive statistics, probability, confidence intervals, hypothesis testing, simple linear regression, correlation, Chi-Square, and Analysis of Variance.

Attributes: GE IB Communication-Analytical Skills, LE-S2 Mathematics
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 291 Special Topics (1-3 crs)
Topics will vary, depending on interest of students and faculty.
Repeat: Course may be repeated for a maximum of 9 credits

MATH 297 Developmental Tutoring Techniques (1 cr)
- May not be counted for credit toward a major or minor in mathematics except in the Comprehensive Major: Mathematics Teaching emphasis or the Minor: Mathematics, Middle Childhood/Early Adolescence, Teaching.

Training and tutoring for developmental mathematics courses.
Repeat: Course may be repeated for a maximum of 4 credits
Seminar Hours: 1

MATH 302 Algebraic Thinking (2 crs)
Prerequisite: MATH 202. Limited to elementary and special education majors and minors.

Mathematical knowledge for teachers based on practice/content standards. Topics include: algebraic equations, linear functions, non-linear functions, and introduction to formal justification.

Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MATH 303 Probability and Statistical Thinking (2 crs)
Prerequisite: MATH 202. Limited to elementary and special education majors and minors.

Mathematical knowledge for teachers based on practice/content standards. Topics include: statistics, probability, and expected value.

Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MATH 304 Geometric Thinking (2 crs)
Prerequisite: MATH 202. Limited to elementary and special education majors and minors.

Mathematical knowledge for teachers based on practice/content standards. Topics include: 2D & 3D figures, and transformations.

Lecture/Discussion Hours: 2
Lab/Studio Hours: 0

MATH 305 Mathematics for Elementary/Middle School Teachers III (3 crs)
Prerequisite: MATH 204 or concurrent enrollment. Exceptions to the MATH 204 prerequisite may be made with the instructor's approval. Limited to elementary and special education majors and minors. Minimum junior standing.
- Counts only toward the elementary teaching minor in mathematics.

An integrated study of mathematics content, methods, and curricula. Topics include statistics, measurement, geometries, patterns, and functions. Emphasis on communication and algebraic thinking. Practicum experience included.

Attributes: GE IB Communication-Analytical Skills
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
MATH 307 Mathematics and Music (3 crs)
Prerequisite: MATH 114 (or equivalent) or consent of instructor.
Using mathematics to understand, appreciate, and create music. Free audio processing software will be emphasized. Rock, jazz, classical, and experimental music will be analyzed. Connections are made to brain science and medicine.

Attributes: GE V University Wide, LE-I1 Integration, LE-S3 Creativity, Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 311 Differential Equations (3 crs)
Prerequisite: MATH 216. Credit may not be earned in both MATH 311 and MATH 312.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 312 Differential Equations and Linear Algebra (4 crs)
Prerequisite: MATH 215. Credit may not be earned in both MATH 311 and MATH 312.
Linear algebra: basis, dimension, matrix algebra, determinants, inverses, systems of linear equations, eigenvalues/eigenvectors. (Optional) matrices as linear transformations. Differential equations: first-order linear, separable; second-order linear with constant coefficients; higher order differential equations; first-order linear systems with constant coefficients; Laplace transforms; power series solutions. (Optional) Proof of Existence and Uniqueness Theorems.

Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 313 Digital Signal Processing (3 crs)
Prerequisite: MATH 215 or consent of instructor.
Fundamentals of digital signal processing. Fourier series, Fourier transforms and computerized Fourier transforms (FFTs) are described and applied to the analysis of digitized audio and digitized images.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 314 Discrete Mathematics (3 crs)
Prerequisite: MATH 114 or MATH 212. No credit if taken after CS 240.
Introductory course in discrete mathematics. Topics include elementary combinatorics, graph theory, trees, and Boolean algebra. The course emphasizes an algorithmic approach to problem solving.

Attributes: GE IB Communication-Analytical Skills, Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 315 Advanced Calculus I (3 crs)
Prerequisite: MATH 216 and MATH 324.
Differential and integral calculus of several variables; vector calculus; line, surface, and space integrals including Green's theorem, Divergence theorem, and Stokes' theorem.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 316 Introduction to Real Analysis (3 crs)
Prerequisite: MATH 216 and MATH 324.
Real numbers, introductory topological topics, limits, sequences of numbers, continuity, sequences of functions, and series.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 317 Introduction to Real Analysis II (3 crs)
Prerequisite: MATH 316
Differentiation and integration in Rn, Riemann-Stieltjes integral, functions of bounded variation, implicit function theorem, introduction to metric spaces including Arzela's Theorem and Tietze extension Theorem, and selected topics in analysis.

Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 318 Introduction to Complex Variables (3 crs)
Prerequisite: MATH 216
Elementary functions of a complex variable, complex integrals, and residue theory.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 322 Abstract Algebra for Elementary Teachers (4 crs)
Prerequisite: MATH 114 and MATH 202. Limited to elementary education majors.
• May not be counted for credit toward a major or minor in mathematics except in mathematics teaching programs.

Includes sets, functions, and abstract algebraic structures such as groups, rings, and fields.

Lecture/Discussion Hours: 4
Lab/Studio Hours: 0
MATH 324 Linear Algebra (4 crs)
Prerequisite: MATH 215
An introductory course in linear algebra including matrix algebra, systems of linear equations, vector spaces, linear transformations, eigenvalues, and applications. Also covers methods of proof and a survey of student-faculty research.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 330 Modern Geometry (4 crs)
Prerequisite: MATH 114
• Requires basic knowledge of Euclidean Geometry.
Contemporary and classical Euclidean geometry, with emphasis on constructions, transformations, and proofs. The Mira and geometry software will be used to illustrate these topics. Some non-Euclidean geometry included.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 335 Introduction to Point-Set Topology (3 crs)
Prerequisite: MATH 324
Theory of sets, continuity of functions, neighborhoods of points, topological and metric spaces, connectedness and compactness.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 338 Introduction to Differential Geometry (3 crs)
Prerequisite: MATH 216
An introduction to the study of curves and surfaces. Topics on curves include curvature, torsion, and the Frenet frames. Topics on surfaces include curvature, minimal surfaces, and Gauss’ Remarkable Theorem.

Lecture/Discussion Hours: 2.5
Lab/Studio Hours: 0.5

MATH 339 Relativity and Differential Geometry (4 crs)
Prerequisite: MATH 216, PHYS 232
The theories and history of special and general relativity. Manifolds, tensors, and metrics as they relate to relativity. Modern research in relativity and astronomy.

Attributes: LE-I1 Integration
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 341 Classical Number Theory (3 crs)
Prerequisite: MATH 114
Classical number theory including divisibility, primes and their properties, theory of congruences, Diophantine equations, number theoretic functions, primitive roots, and selected optional topics.

Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 342 Mathematical Logic and Proof (3 crs)
Prerequisite: MATH 215
Introductory logic statements, inference, quantification, and methods of proof with applications in sets, number theory, relations, and algebra.

Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 345 Introduction to Probability and Mathematical Statistics (4 crs)
Prerequisite: MATH 215 or concurrent registration. Credit may not be earned in both MATH 345 and MATH 346.

• MATH 246 may not be taken for credit after or concurrently with MATH 345.

Counting techniques, discrete and continuous random variables, probability distributions, sampling distributions, estimation, hypothesis testing, linear regression, correlation, nonparametric statistics. Students who desire more extensive probability and statistics should take Math 346/Math 546, Math 347/Math 547.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 346 Introduction to Probability (4 crs)
Prerequisite: MATH 216 or concurrent enrollment. Credit may not be earned in both MATH 345 and MATH 346.

Probability in discrete and continuous sample spaces; conditional probability; counting techniques; probability functions; binomial, Poisson, normal distributions; and transformations of variables.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 347 Mathematical Statistics (4 crs)
Prerequisite: MATH 215; MATH 346.

• MATH 246 may not be taken for credit after or concurrently with MATH 347.

Sampling distributions; estimation and properties; hypothesis testing; analysis of variance; regression; nonparametric tests; and introduction to Bayesian inference.

Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 2
MATH 350 Introduction to Financial Mathematics (4 crs)
Prerequisite: MATH 215 or consent of instructor.
Mathematical theory of interest, annuities and applications, loans, portfolio management, securities valuation, and determinants of interest rates.
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 351 Numerical Analysis I (3 crs)
Prerequisite: MATH 215
Nonlinear equations, interpolation and approximation, least squares, systems of linear equations, and error analysis.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 352 Numerical Analysis II (3 crs)
Prerequisite: MATH 215 and either one of the following: CS 163, CS 170, CS 255 (now CS 335), or consent of instructor.
Numerical solution of differential equations, numerical differentiation and integration, and the eigenvalue problem.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 354 Introduction to Mathematical Modeling (4 crs)
Prerequisite: MATH 215
Introduction to building mathematical models in an applied context, including principles of modeling; project(s) involve modeling open-ended real-world problems. Skills covered may include discrete dynamical systems, differential equations, stochastic models, and linear programming.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 355 Linear Programming (3 crs)
Prerequisite: MATH 215
Introductory topics in linear programming including computational development of the simplex method, duality theory of linear programming, dual simplex method, transportation problem, and the use of a linear programming package.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 358 Introduction to Optimization (3 crs)
Prerequisite: MATH 215
An introduction to the theory and application of optimization techniques. Analytic and numerical methods for linear and nonlinear problems of both constrained and unconstrained type will be considered.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 365 Patterns of Problem Solving (4 crs)
Prerequisite: Minimum-level University Mathematics Competency.
- May not be counted for credit toward a major or minor in mathematics except in mathematics teaching programs.
Provides tools and concepts needed in problem solving in a variety of disciplines.
Attributes: GE IB Communication-Analytical Skills, LE-S3 Creativity
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 373 Issues in Secondary Mathematics (4 crs)
Prerequisite: MATH 345 or MATH 346 or concurrent enrollment; MATH 330 or concurrent enrollment. Limited to mathematics teaching majors.
- This is a hybrid course offering.
An integrated study of mathematical topics taught in grades 5-12 with a focus on increasing pedagogical content knowledge. Topics covered include algebraic, geometric, and other relevant issues in secondary mathematics.
Grading Basis: A-F Grades Only
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 380 Research Methods (3 crs)
Prerequisite: MATH 324 or consent of instructor.
Introduction to research methods in mathematics. Topics include: background research, methods of proof, mathematical writing, and presentation skills.
Attributes: LE-S3 Creativity
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 395 Directed Studies (1-3 crs)
Prerequisite: 2.00 GPA in mathematics.
Consent: Department Consent Required
For the student who wishes to pursue independent study of a topic in mathematics under the supervision of a member of the mathematics department.
Repeat: Course may be repeated

MATH 399 Independent Study - Juniors (1-3 crs)
Prerequisite: Minimum junior standing.
Consent: Department Consent Required
Individual project under the direction of a faculty member.
Repeat: Course may be repeated

MATH 425 Abstract Algebra I (3 crs)
Prerequisite: MATH 324
An introduction to the abstract concepts of algebra such as groups, rings, and fields. Topics such as direct products, group homomorphisms, factor groups, integral domains, and polynomial rings will be included.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisite(s)</th>
<th>Description</th>
<th>Attributes</th>
<th>Lecture/Discussion Hours</th>
<th>Lab/Studio Hours</th>
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<tr>
<td>MATH 426 Abstract Algebra II (3 crs)</td>
<td>Prerequisite: MATH 425/MATH 625. No credit if taken after MATH 322. A continuation of Math 425 including more advanced topics from groups, rings, and fields, such as the Sylow theorems, prime and maximal ideals, unique factorization domains, and finite fields.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 3</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 440 Digital Image Processing (3 crs)</td>
<td>Prerequisite: MATH 215; Credit may not be earned in both MATH 440 and PHYS 440. Applications of Fourier analysis and wavelets to optics and image processing. Topics include: diffraction, wave optical theory of lenses and imaging, wavelets, and image processing.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 3</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 441 Linear Regression Analysis, with Time Series (4 crs)</td>
<td>Prerequisite: MATH 345 or MATH 347 or MATH 246, and MATH 114. Simple and multiple regression, transformation of variables, model checking, analysis of residuals, regression diagnostics, stepwise regression, index variables, confidence intervals, and computer software; overview of time series and forecasting methods.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 4</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 443 Experimental Design and Analysis (3 crs)</td>
<td>Prerequisite: MATH 345 or MATH 347 or MATH 246 Basic concepts of statistical design of experiments; linear models; randomized block, Latin square, factorial, fractional factorial, rotatable, and incomplete block designs and applications.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 3</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 445 Survey Sampling (2 crs)</td>
<td>Prerequisite: MATH 345 or MATH 347 or MATH 246 Survey sampling including random sampling, stratified sampling, cluster sampling, and design of surveys.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 2</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 447 Nonparametric Statistics (2 crs)</td>
<td>Prerequisite: MATH 345 or MATH 347 or MATH 246 Testing and estimation based on the binomial distribution, contingency tables, Wilcoxon Tests, rank correlation, Kruskal-Wallis and Friedman analysis of variance. Comparisons with parametric methods.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 2</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 450 Foundations of Actuarial Science (4 crs)</td>
<td>Prerequisite: Admission to the Actuarial Science program Actuarial theory of financial mathematical models for contingent events as applied to insurance, annuities, pensions, and reserving. Together with Math 460, this course prepares students for the actuarial exam covering contingent payments.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 4</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 451 Teaching Mathematics with Technology (4 crs)</td>
<td>Prerequisite: ES 203 or ES 210/ES 211 or ES 212; MATH 114. Credit may not be earned in both MATH 451/MATH 651 and MATH 453/MATH 653.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 4</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 456 Operations Research (2-3 crs)</td>
<td>Prerequisite: MATH 215 Students who have earned credit in an upper-division linear programming course may earn only two credits in this course. This two-credit option is available only to those who have taken such a course. For students earning two credits due to this restriction, attendance will be optional during the linear programming unit. An introduction to the theory and application of operations research techniques. Several important topics including linear programming, inventory models, waiting time models, and replacement models will be discussed.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 3</td>
<td>Lab/Studio Hours: 0</td>
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<td>MATH 460 Contingent Payment Analysis (4 crs)</td>
<td>Prerequisite: MATH 450 and Admission to the Actuarial Science Program (Code 180-001). Actuarial theory of reserves, multiple life models, multiple decrement models, Poisson processes, and multi-state transition models. Together with Math 450, this course prepares students for the actuarial exam covering contingent payments.</td>
<td>Undergraduate/Graduate Offering</td>
<td>Lecture/Discussion Hours: 4</td>
<td>Lab/Studio Hours: 0</td>
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MATH 462 History of Mathematics (3 crs)
Prerequisite: MATH 114
A study of mathematics from a historical point of view beginning with the work of the early Greek mathematicians and including selected mathematicians and periods of mathematical development up to the present.
Attributes: LE-I Integration, Undergraduate/Graduate Offering
Lecture/Discussion Hours: 3
Lab/Studio Hours: 0

MATH 470 Mathematical Models for Financial Economics (4 crs)
Prerequisite: Admission to the Actuarial Science Program (Code 180-001).
An introduction to financial derivatives including forwards and options with coverage of binomial, Black-Scholes, and lognormal pricing models.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 475 Actuarial Foundations of Short-Term Coverages (4 crs)
Prerequisite: MATH 347. Admitted to Actuarial Science Program. No credit if taken after MATH 491 when offered as Introduction to Credibility & Loss Models
An introduction to ratemaking and reserving for short-term insurance coverages; credibility theory; and actuarial models for frequency, severity, and aggregate distributions.
Attributes: Undergraduate/Graduate Offering
Lecture/Discussion Hours: 4
Lab/Studio Hours: 0

MATH 480 Research Seminar (2 crs)
Prerequisite: MATH 380 and faculty supervised research project
Consent: Instructor Consent Required
Individual research projects in mathematics under the supervision of a member of the mathematics faculty, culminating in research project presentations.
Repeat: Course may be repeated for a maximum of 4 credits
Lab/Studio Hours: 0
Seminar Hours: 2

MATH 491 Special Topics (1-4 crs)
A variable content course designed to allow a breadth of study through investigation of mathematical topics not covered in other courses. Special interests of instructors will be utilized to provide topics.
Attributes: Undergraduate/Graduate Offering
Repeat: Course may be repeated for a maximum of 9 credits

MATH 493 Capstone Seminar (1 cr)
Prerequisite: Minimum senior standing.
Consent: Department Consent Required
An intensive study of selected topics including written and/or oral presentations by the students. The topics will connect ideas from across the mathematics major.
Attributes: Capstone Course
Repeat: Course may be repeated for a maximum of 3 credits
Lecture/Discussion Hours: 1
Lab/Studio Hours: 0

MATH 494 Mathematics Seminar (1 cr)
Prerequisite: Minimum junior standing.
An intensive study of selected topics in mathematics. The exact topics to be studied will vary according to the interests of the professor and the seminar participants.
Attributes: Undergraduate/Graduate Offering
Repeat: Course may be repeated for a maximum of 3 credits
Lecture/Discussion Hours: 1
Lab/Studio Hours: 0

MATH 497 Honors Seminar (1 cr)
Prerequisite: Grade of B+ or above in MATH 216.
• Admission to Department Honors Program.
An intensive study of selected topics in mathematics. The exact topics to be studied will vary according to the interests of the professor and the seminar participants.
Repeat: Course may be repeated for a maximum of 3 credits
Lecture/Discussion Hours: 1
Lab/Studio Hours: 0
Seminar Hours: 1

MATH 498 Mathematics Internship (1-3 crs)
Prerequisite: MATH 216. Limited to mathematics majors and minors. Minimum junior standing.
Consent: Department Consent Required
• May not count toward the minimal number of credits required for a mathematics major or minor.
Provides supervised on-the-job experience in an area of interest with mathematical content.
Attributes: Service-Learning Optional, Internship
Repeat: Course may be repeated for a maximum of 6 credits
Grading Basis: No Auditors

MATH 499 Independent Study - Seniors (1-3 crs)
Prerequisite: Minimum senior standing.
Consent: Department Consent Required
Individual project under the direction of a faculty member.
Repeat: Course may be repeated