

## Mathematics

The Mathematics Department offers its majors an energetic and dedicated faculty who find the world of mathematics exciting and challenging, and coursework that provides them with opportunities to experience the wonders of mathematics themselves.

The Mathematics faculty is proud of their commitment to creative classroom instruction and active learning. Examples of these alternative educational experiences include the use of activities and projects, portfolios, group work and cooperative learning, guided discovery approaches to problem solving, outside mathematics activities, sidewalk chalk mathematics, writing about mathematics, reading and writing about mathematical literature, sending student groups to the blackboards, explorations using mathematical manipulatives, student presentations at conferences, innovative faculty-developed course materials in lieu of standard textbooks, community service, and technology. Many of these pedagogies, by requiring that students work together, help to create an inclusive, interactive learning environment where students develop important communication and interpersonal relationship skills.

Mathematics graduates work as teachers, actuaries, industry mathematicians, for government agencies, and in many other fields requiring their specialized skills. Our majors have gone on to earn graduate degrees in mathematics, statistics, and information technology.

### REQUIREMENTS FOR MATHEMATICS MAJORS

Requirements (39 credits)

MATH 0105 Calculus I	(4)
MATH 0106 Calculus II	(4)
MATH 0220 Discrete Structures	(3)
MATH 0218 Linear Algebra	(3)
MATH 0201 Calculus III	(4)
MATH 0390 Senior Seminar in Mathematics	(3)
Six (6) additional 0300-level, 3-credit mathematics courses	(18)

At most, 6 credits of any combination of MATH 0360 and MATH 0399 can count toward the major.

### LICENSURE FOR TEACHER OF MATHEMATICS (5-8, 8-12)

The Westfield State University program for licensure for teachers of Mathematics has been recognized by the National Council of Teachers of Mathematics.

Student progress toward meeting Advanced Standing in Teacher Education is monitored at the end of the sophomore year (57 credits). Please see section on Licensure for Teacher Education.

In order to be eligible for student teaching, a student must have completed all required course and field work, have an overall GPA of 2.8 (including transfer work), and have a passing grade in the appropriate Massachusetts Tests for Educator Licensure (i.e., Communication and Literacy and subject matter tests).

Undergraduate mathematics majors who wish to be certified to teach Mathematics at the Middle or High School levels must:

Choose their math major electives to satisfy the mandated teacher certification competencies;

Complete the courses that satisfy certification competencies with no grade lower than C;

Complete the Professional Sequence for Middle and Secondary Specialist, described in the Education Department listings;

Take MATH 0337, Foundations of Secondary and Middle School Mathematics.

### REQUIREMENTS FOR MATHEMATICS MINORS (18 CREDITS)

The minor in mathematics consists of 18 credits of mathematics courses including

MATH 0105 Calculus I	(4)
MATH 0106 Calculus II	(4)

Any 200-level or 300-level mathematics course can count towards the minor.

At most two additional 100-level mathematics courses can count towards the minor.

CAIS 0351, Theory of Computation, can count towards the minor.

### REQUIREMENTS FOR THE DOUBLE MAJOR: MATHEMATICS AND ECONOMICS

By selecting appropriate core courses and mathematics electives, a Mathematics major may add a second major in Economics by completing 15 credits of additional upper-level coursework in Economics.

Required Core Courses (6 credits)

ECON 0101 Principles of Macroeconomics	(3)
ECON 0102 Principles of Microeconomics	(3)

Required Economics Courses (6 credits)

ECON 0201 Microeconomic Theory	(3)
ECON 0202 Macroeconomic Theory	(3)

Economics Elective Courses (9 credits)

ECON 0300 Money and Banking	(3)
ECON 0301 Law and Economics	(3)
ECON 0302 Economic History of the United States	(3)
ECON 0303 Economics of Development	(3)
ECON 0304 Urban Economics	(3)
ECON 0305 Introduction to Econometric Methods	(3)
ECON 0306 Managerial Economics	(3)
ECON 0307 Economics of Gender, Race & Ethnicity	(3)
ECON 0312 Labor Economics	(3)
ECON 0314 Industrial Organization	(3)
ECON 0315 Public Finance	(3)
ECON 0316 Economic History of Europe	(3)
ECON 0318 International Economics	(3)
ECON 0319 Development of Economic Thought	(3)

ECON 0320 Environmental Economics	(3)
ECON 0321 Natural Resource Economics	(3)
ECON 0322 Economics of Sports	(3)
ECON 0350 Current Economic Issues	(3)
ECON 0398 Senior Research Seminar	(3)
ECON 0399 Independent Study	(3-6)
MGMT 0338 International Business	(3)

#### Mathematics Elective Courses (6 credits)

Students double-majoring in mathematics and economics must take two of the following mathematics courses. These two mathematics courses will count towards fulfilling the requirements of both majors.

MATH 0333 Applied Statistics	(3)
MATH 0334 Operations Research and Modeling	(3)
MATH 0340 Mathematical Statistics I	(3)
MATH 0341 Mathematical Statistics II	(3)

## Courses

**MATH 0104 PRE-CALCULUS (3)** Topics covered include an in-depth investigation of functions; graphing; exponential and logarithmic functions; and trigonometry. Prerequisite: High School Algebra II.

**MATH 0105 CALCULUS I (4)** A standard first semester course in calculus. Topics include limits and continuity, the derivative and its properties, applications of differentiation, introduction to anti-differentiation, the definite integrals, and the Fundamental Theorem of Calculus. Prerequisite: Four years of High School mathematics, including Algebra I and II and Geometry, or MATH 0104.

**MATH 0106 CALCULUS II (4)** A continuation of Calculus I. Topics include techniques of integration, applications of the integral, series and sequences, L'Hôpital's Rule, approximation of functions. Prerequisite: MATH 0105.

**MATH 0108 ELEMENTARY STATISTICS (3)** An introduction to basic concepts and techniques of statistics for students needing skills for research techniques in education, business, and the physical, life, and social sciences, or simply to understand the mass of statistical information in modern life. Topics include: graphical techniques such as histograms or box plots; measures of location and spread; scatter plots and correlation; sampling and sampling distributions; estimation and statistical inference (confidence intervals and/or hypothesis testing). Prerequisite: High School Algebra II.

**MATH 0110 MATHEMATICAL EXPLORATIONS (3)** An introductory course designed to provide the liberal arts major with an opportunity to develop a broader appreciation of mathematics by exploring ways in which the artistic, aesthetic, intellectual, and humanistic aspects of mathematics are as important as its utility. Topics may include: mathematical reasoning, the infinite, topology, chaos and fractals, symmetry, elementary number theory, modern geometry, and the history of mathematics. Prerequisite: High School Algebra II.

**MATH 0111 MATHEMATICAL APPLICATIONS (3)** An introductory course designed to provide the liberal arts major with opportunities to investigate ways in which mathematics is used to solve real world problems in a variety of disciplines. Applications may include such topics as voting schemes, fair division, networks, scheduling, finance, probability and statistics. Prerequisite: High School Algebra II.

**MATH 0115 MATHEMATICS FOR BUSINESS AND SOCIAL SCIENCES (3)** An introduction to algebraic modeling, with an emphasis on applications in business and the social sciences. Topics include: using algebraic models to describe the relationship between variables, using graphs to visualize models, and choosing and interpreting various models. Calculus is introduced and is used as a tool for studying the structure of algebraic models. Prerequisite: High School Algebra II.

**MATH 0153 FOUNDATIONS: NUMBER SYSTEMS (3)** An introductory course on number systems. Topics will include: the development and properties of various number systems (such as integers, rational, real, and complex numbers); and operations and different representations in these number systems (such as those in bases other than 10). Students will develop a conceptual understanding of the course material in a learning environment that models the pedagogical foundations of the Massachusetts Curriculum Frameworks for Mathematics and the National Council of Teachers of Mathematics (NCTM) Standards. Prerequisite: High School Algebra II.

**MATH 0201 CALCULUS III (4)** A continuation of Calculus II. Topics include vector functions and calculus of curves in space, differential calculus of multivariate functions, integral calculus of multivariate functions, polar, spherical and cylindrical coordinates, parametric equations, Cartesian coordinates, line and surface integrals. Prerequisite: MATH 0106 and MATH 0218

**MATH 0216 STUDIES IN THE LITERATURE OF MATHEMATICS (3)** A study of mathematical literature devoted to selected topics from fundamental scientific, philosophical, artistic, cultural, and technological questions, debates, and revolutions. Source material will be taken from the widely varied genres of mathematical literature: fiction, drama, essays, memoirs, exposition for lay audiences, history, and philosophy. Regular class discussions, regular writing assignments, poster projects, and research papers actively will involve students in analyzing and/or creating literature, which reflects both their role in and the understanding of the mathematical experience. Prerequisites: ENGL 0101 and at least one 0100-level mathematics course.

**MATH 0218 LINEAR ALGEBRA (3)** Study of fundamental concepts of linear algebra over the field of real numbers. Topics include solution of simultaneous linear equations, vector spaces, linear independence and dependence, basis, subspaces, linear transformations and matrices, eigenvalues, eigenvectors. Prerequisite: MATH 0105.

**MATH 0220 DISCRETE STRUCTURES (3)** An introduction to discrete mathematics. Topics will include Boolean algebra and logic, set theory, an introduction to mathematical proof using set theory and logic, relations and functions, recursion, and historical topics related to discrete mathematics, such as Godel's Theorem and the concept of Turing machines. Additional topics, such as graph theory or finite difference equations, may be covered at the instructor's discretion. Prerequisite: MATH 0105.

**MATH 0250 FOUNDATIONS: PATTERNS, REASONING AND ALGEBRA (3)** An introductory course in the foundations of mathematics. Topics include: finding, analyzing, and describing patterns; sets and classification; functions and relations; inductive and deductive reasoning; problem solving; and logic. Students will develop a conceptual understanding of the course material in a learning environment that models the pedagogical foundations of the Massachusetts Curriculum Frameworks for Mathematics and the National Council of Teachers of Mathematics (NCTM) Standards. Prerequisite: MATH 0153.

**MATH 0251 FOUNDATIONS: GEOMETRY (3)** An introductory course on geometry and measurement. Topics will include: Euclidean geometry, characteristics and properties of 2- and 3-dimensional shapes, topology, symmetry and transformational geometry, the development of measure, and the derivation of measurement formulae. Students will develop a conceptual understanding of the course material in a learning environment that models the pedagogical foundations of the Massachusetts Curriculum Frameworks for Mathematics and the National Council of Teachers of Mathematics (NCTM) Standards. Prerequisite: MATH 0153.

**MATH 0252 FOUNDATIONS: DATA ANALYSIS AND PROBABILITY (3)** The study of the foundations of data analysis and probability. Topics will include understanding, constructing, and computing data graphs and numerical summary measures; probability models; and statistical inference. Students will develop a conceptual understanding of the course material in a learning environment that models the pedagogical foundations of the Massachusetts Curriculum Frameworks for Mathematics and the National Council of Teachers of Mathematics (NCTM) Standards. Prerequisite: MATH 0153

**MATH 0301 ABSTRACT ALGEBRA I (3)** A study of groups, rings, integral domains and fields, with special emphasis on the real and complex fields. Prerequisite: MATH 0311.

**MATH 0304 DIFFERENTIAL EQUATIONS (3)** Geometric and physical meaning of differential equations. Theory and solution of first, second and higher order linear and non-linear differential equations. Initial and boundary value problems. Finite difference equations. Prerequisites: MATH 0106 and MATH 0218.

**MATH 0306 MODERN GEOMETRIES (3)** An integrated course consisting of intuitive, synthetic, and analytic approaches to Euclidean and other geometries. Topics will include axiomatic foundations, finite geometries, non-Euclidean geometries, and synthetic projective geometry. Prerequisite: MATH 0218.

**MATH 0308 REAL ANALYSIS (3)** Topology of real numbers, Cauchy sequences, metric completeness, continuity, compactness, connectedness. Sequence and series and uniform convergence of infinite series. Derivatives and definite integrals. Prerequisite: MATH 0201.

**MATH 0309 TOPOLOGY (3)** A simple, thorough survey of the elementary topics of point-set topology of the real line and plane topological spaces; metric spaces; mappings; connectedness; compactness. Prerequisite: MATH 0201.

**MATH 0311 NUMBER THEORY (3)** Properties of integers including congruence, primes and factorization, continued fractions, quadratic residues, linear diophantine equations and number theoretic functions. Prerequisite: MATH 0105.

**MATH 0323 COMPLEX ANALYSIS (3)** Algebra of complex numbers, analytic functions, Cauchy Riemann conditions, conformal mapping, line integrals, Cauchy integral formula, residue integration, Taylor and Laurent series. Prerequisite: MATH 0201.

**MATH 0333 APPLIED STATISTICAL AND EXPERIMENTAL DESIGN (3)** A study of the application of statistical procedures employed in empirical research and methods used in interpreting numerical results. Topics in statistics include: introduction to descriptive and inferential statistics, hypothesis testing, parametric and non-parametric tests (correlation, regression, the t-test, analysis of variance, and factor analysis). The underlying assumptions of several experimental designs will also be examined. Prerequisite: MATH 0108 or MATH 0252 or MATH 0340.

**MATH 0334 OPERATIONS RESEARCH AND MODELING (3)** A study of mathematical modeling and of the models of interest in operations research, which may include distribution problems, linear programming, the simplex method and applications. CPM, network problems, non-linear programming problems, Markov chains, queuing models, and simulation. Prerequisites: MATH 0106 and MATH 0218.

**MATH 0335 NUMERICAL ANALYSIS (3)** Intended for majors in mathematics or computer science. Methods of finding approximate numerical solutions to mathematical problems are explored using a scientific computer programming language. Standard algorithms of numerical analysis will be chosen from: numerical integration, non-linear equations, computational probability, differential equations. Prerequisites: MATH 0106 and MATH 0218.

**MATH 0337 FOUNDATIONS OF SECONDARY AND MIDDLE SCHOOL MATHEMATICS (3)** Designed to build upon student's mathematics background, relating students' mathematical knowledge to understanding and teaching the middle or secondary school mathematics curriculum. Topics to be considered are: geometry, algebra, basic skills, number theory, probability and statistics and the use of calculators and computers in the classroom. A thirty (30) hour field experience is a course requirement. Prerequisites: Junior/senior standing in the major.

**MATH 0340 MATHEMATICAL STATISTICS I (3)** A calculus-based introduction to probability and statistics. Topics include graphical techniques for data analysis (histograms, stem&leaf displays, box plots), set theory, principles of counting, sample spaces, discrete and continuous probability distributions, probability functions, random variables, moment-generating functions, statistical inference (point estimation, decision-making based on confidence intervals/hypothesis testing). Prerequisite: MATH 0106.

**MATH 0342 ACTUARIAL PROBLEM SOLVING (3)** Develops knowledge of the fundamental probability tools for quantitatively assessing risk. The application of these tools to problems encountered in actuarial science is emphasized. A thorough command of probability topics and the supporting calculus is assumed. Additionally, a very basic knowledge of insurance and risk management is helpful. This course is designed to help prepare for actuarial certification and employment. This course may be available every other year by special arrangement with one of the mathematics faculty. Prerequisites: MATH 0201 and MATH 0340.

MATH 0352 FOUNDATIONS OF TEACHING MATHEMATICS: PREK-6 (2) Designed to introduce the prospective early childhood, elementary, and special education school teacher to the teaching of mathematics. An activity-based format will be used to create a learning environment that fosters an exploration of the processes of mathematics. Emphasis will be placed on the role and use of manipulatives in a laboratory setting that encourages the development of fundamental concepts in mathematics. Topics may include: the inductive and deductive processes, measurement, graphing, cognitive development theory, the learning cycle, discussion of innovative projects, state and national frameworks, techniques for assessment, number and arithmetic operations, patterns, variables, modeling and geometry. Three contact hours per week, including substantial laboratory/activity time. Prerequisite: MATH 0250.

MATH 0353 MATHEMATICS TEACHING APPRENTICESHIP (3) Provides prospective teacher candidates with a mathematically focused pre-practicum teaching/mentoring experience in a local school. Students will put the methods of teaching mathematics developed in MATH 0352 into practice by working with students on a weekly basis throughout the semester. Their work will be supervised by both the elementary school classroom teacher and the University faculty member who will regularly be on site. Content of class meetings will focus on reflection, assessment, and analysis of these experiences. Can be repeated for credit with permission of instructor. Not for MATH only majors – does not count in the 6 300-level requirement. Prerequisite: MATH 0352.

MATH 0360 CURRENT TRENDS IN MATHEMATICS AND MATHEMATICS EDUCATION (1-3) Students will work individually with a professor on a project or activity relating to current innovations in mathematics or mathematics education. Potential sources for study include: evaluation of innovative textual materials, trends in media and technology development, evaluation of software, development of laboratory materials, attendance at professional conferences, review and analysis of journal articles, and the presentation of reports on individual and institutional research activities. Course may be taken up to two times with the permission of the department chair. Prerequisite: Permission of instructor.

MATH 0390 SENIOR SEMINAR IN MATHEMATICS (3) A capstone experience for senior mathematics majors which unifies many areas of the undergraduate curriculum and serves as a rite of passage into the community of mathematicians. The curriculum is topical in nature and varies by course offering. Topics studied are of contemporary importance and are considered from their historical genesis through their current role in the ongoing development of the field of mathematics. Prerequisite/Corequisite: Five (5) 300 level 3-credit Math courses.

MATH 0398 INTERNSHIP IN MATHEMATICS (3-15) Internship in mathematics for full-time, upper level mathematics majors. Prerequisites: Junior/senior standing **and** dept. permission.

MATH 0399 INDEPENDENT STUDY (1-6) Independent study of topics in mathematics under careful faculty supervision. Intended for capable students to broaden their mathematics program or to gain depth in a particular area of interest. Prerequisite: permission of instructor and department Chair.