

# MATHEMATICS (MA)

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## MA 100 - Quantitative Reasoning

Credits: 3

A practical study of the skills and tools needed to work with quantitative information from the real world. Students will learn and explore mathematical concepts such as arithmetic, fractions, decimals, percentages, descriptive statistics and basic probability, estimation, unit analysis, absolute and relative change, and linear and exponential growth. Students will also represent and interpret numerical data in tabular and graphical forms. Material will be applied to a wide variety of fields.

## MA 102 - Mathematical Models in the Social and Management Sciences

Credits: 3

In many areas of the social and management sciences, mathematics can be used to make predictions, help allocate scarce resources, maximize profits, make policy decisions, and so on. This use of mathematics is called mathematical modeling. In this course we investigate a variety of scenarios which can arise in the "real world" where math modeling can come into play, and we learn about some of the most important techniques of math modeling such as linear programming, probability theory, statistical techniques, integer programming, and Markov chains.

**Note(s):** Course offered periodically, depending on faculty availability. Fulfills QR2 requirement.

## MA 103 - Assume a Spherical Cow: A First Course in Math Modeling

Credits: 4

Provides students with an opportunity to study interdisciplinary problems through a quantitative lens. During the course, students will build models, analyze and interpret results using traditional mathematics and computer-based simulations, and present their findings in both written and oral presentations. Students will explore problems from many disciplines including ecology, biology, finance, and epidemiology. Modeling techniques studied in this course include discrete dynamical systems and stochastic models.

**Prerequisites:** FQR course or placement at AQR.

**Note(s):** Fulfills AQR requirement.

## MA 107 - Concepts of Mathematics

Credits: 3

An introductory course for liberal arts and education majors or anyone seeking a general, nontechnical overview of mathematics. Topics covered include set theory, review of number systems, geometry concepts, basic concerns of probability and statistics, and introductory number theory.

**Note(s):** Offered periodically depending on faculty availability. Fulfills QR2 requirement.

## MA 108 - Calculus with Algebra I

Credits: 3

An introduction to derivatives, integrals, and their applications. Primarily for students who are not adequately prepared for MA 111, this course (together with MA 109) covers the same material as MA 111 but integrates the material requisite to calculus with the calculus itself. Note that MA 108 alone cannot be used as a substitute for MA 111. Successful completion of MA 108 and MA 109 is equivalent to completion of MA 111.

**Prerequisites:** QR1 or MA 100 or placement at the FQR level or placement at the AQR level

**Note(s):** Offered fall semester.

## MA 109 - Calculus with Algebra II

Credits: 3

A continuation of MA 108. A study of exponential, logarithmic, and trigonometric functions and their applications in differential and integral calculus. Successful completion of MA 108 and MA 109 is equivalent to completion of MA 111.

**Prerequisites:** MA 108.

**Note(s):** Offered spring semester. Fulfills QR2 requirement; fulfills Fundamental QR requirement.

## MA 110 - Mathematics Toolkit

Credits: 3

A detailed study of the mathematical tools necessary for success in calculus and statistics courses. Students will build their quantitative reasoning skills, with a particular focus on understanding functions and covarying quantities. These skills include creating, refining, and algebraically manipulating models involving polynomials, rational functions, exponentials, logarithms, and trigonometric functions. Students will relate these models to real-life applications and analyze them from symbolic, graphical, and numerical perspectives.

**Prerequisites:** MA 100 or placement into an FQR or AQR course.

**Note(s):** Fulfills Fundamental QR requirement.

## MA 111 - Calculus I

Credits: 4

Derivatives, integrals and their applications. Techniques of differentiation. Integration and differentiation of exponential, logarithmic and trigonometric functions.

**Prerequisites:** High school preparation including trigonometry. Requires AQR placement.

**Note(s):** Fulfills QR2 requirement.

## MA 113 - Calculus II

Credits: 4

An exploration of integral calculus. Topics include techniques of integration, applications of integration, and improper integrals.

**Prerequisites:** Calculus placement exam, or MA 111, or both MA 108 and MA 109. Requires AQR placement.

**Note(s):** Fulfills QR2 requirement.

## MA 113H - Honors:Calculus II

Credits: 4

An exploration of integral calculus. Topics include techniques of integration, applications of integration, and improper integrals.

**Prerequisites:** Calculus placement exam, or MA 111, or both MA 108 and MA 109. Requires AQR placement. (Fulfills QR2 requirement).

## MA 114 - Sequences and Series

Credits: 2

An exploration of infinite sequences and series. Topics include geometric series, convergence tests, Taylor series, and power series.

**Prerequisites:** MA 113 and/or MA 113H taken either before or concurrently.

**MA 116 - Math in the Museum**

Credits: 2

An examination of how mathematical ideas are embodied in the visual arts, architecture, and design, and how the arts have helped shaped advances in math and computer science. From ancient Greek art to the Renaissance, and from Islamic patterns to contemporary computer-generated art, math has an important place in the world of art, architecture, and design both within museum spaces and all around us. Students will explore these relationships in the context of mathematical concepts such as geometry, proportion, basic statistics, measurements, and common functions by studying original works of art and actively engaging with these mathematical concepts through hands on exercises in Skidmore's Tang Teaching Museum.

**Prerequisites:** QR1 or MA 100 or placement at the FQR level or placement at the AQR level.

**Note(s):** Letter grade only. Fulfills Fundamental QR requirement.

**MA 125 - Problem Solving in Mathematics**

Credits: 1

Introductory level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**Prerequisites:** AQR placement.

**Note(s):** During fall semesters, students will have an opportunity to compete in the annual William Lowell Putnam Mathematical Competition. May be repeated for credit. Must be taken S/U.

**MA 125H - Honors: Problem Solving In Mathematics (Fr)**

Credits: 1

Introductory level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**MA 126H - Honors: Problem Solving**

Credits: 1

Introductory level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**MA 200 - Linear Algebra**

Credits: 4

Vector spaces, matrices and linear transformations, determinants, solution of linear equations.

**Prerequisites:** High school preparation including trigonometry. Requires AQR placement.

**Note(s):** Fulfills QR2 requirement.

**MA 202 - Calculus III**

Credits: 4

Multivariable calculus. Topics include vector functions, partial derivatives, multiple integrals, vector fields, and line integrals.

**Prerequisites:** MA 113 or calculus placement exam.

**MA 204 - Probability and Statistics**

Credits: 3

Elementary probability, discrete and continuous random variables, theory of expectation, analysis of distribution functions.

**Prerequisites:** MA 111, or both MA 108 and MA 109.

**Note(s):** Normally offered spring term of odd-numbered years. Fulfills QR2 requirement.

**MA 211 - Calculus III**

Credits: 3

An exploration of multivariable calculus. Topics include parametric equations, polar coordinates, conic sections, vector functions, partial derivatives, and gradients.

**Prerequisites:** MA 113 or calculus placement exam.

**MA 213 - Calculus IV**

Credits: 3

Multivariable calculus. Topics include vector functions, partial derivatives, multiple integrals, vector fields, line integrals, surface integrals, vector calculus, divergence and curl.

**Prerequisites:** MA 211 or MA 202 or permission of instructor.

**MA 214 - Theory of Numbers**

Credits: 3

Topics in classical and modern number theory including congruences, Diophantine equations, quadratic residues.

**Prerequisites:** MA 111, or both MA 108 and MA 109, or MA 200. Requires AQR placement.

**Note(s):** Normally offered spring semester of even-numbered years. Fulfills QR2 requirement.

**MA 215 - Introduction to Mathematical Reasoning and Proof**

Credits: 4

An introduction to mathematical proof and concepts of abstract mathematics. This course serves as the gateway to the mathematics major. Students will learn to think critically, creatively, and inquisitively about mathematics. They will gain proficiency in foundational areas of formal mathematics, including elementary logic, methods of proof, set theory, functions, and relations. Particular attention will be paid to building students' skills in reading, writing, and revising mathematical arguments.

**Prerequisites:** CS 106 or MA 113 or permission of the department.

**Note(s):** Fulfills QR2 requirement.

**MA 225 - Problem Solving In Mathematics**

Credits: 1

Intermediate level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**Prerequisites:** AQR placement.

**Note(s):** During fall semesters, students will have an opportunity to compete in the annual William Lowell Putnam Mathematical Competition. May be repeated for credit. Must be taken S/U.

**MA 225H - Honors: Problem Solving In Mathematics (So)**

Credits: 1

Intermediate level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**MA 226H - Honors: Problem Solving**

Credits: 1

Intermediate level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**MA 251 - Selected Topics in Mathematics**

Credits: 1-4

Topics that complement the established lower level course offerings in mathematics will be selected. Emphasis will be on the nature of mathematical thought.

**Prerequisites:** QR1.**Note(s):** May be repeated for credit. Offered on sufficient demand.**MA 270 - Differential Equations**

Credits: 4

An introduction to the theory and applications of differential equations.

**Prerequisites:** MA 113 and MA 200.**MA 275H - Research Topics in Mathematics**

Credits: 1

Exploration of a research topic in mathematics. The students, in collaboration with a faculty mentor, will participate in a research project in a particular area of mathematics which may be related to the faculty member's research program.

**Prerequisites:** Permission of instructor.**MA 302 - Graph Theory**

Credits: 3

An introduction to the theory and applications of graphs. Topics may include graphs and digraphs, connectivity, trees, Euler and Hamiltonian cycles, and graph embeddings.

**Prerequisites:** MA 215.**Note(s):** Normally offered fall semester of odd-numbered years.**MA 303 - Introduction to Analysis**

Credits: 4

A rigorous introduction to the analysis of the real numbers and real-valued functions of one variable, focusing on the foundations of calculus. Students will learn the properties, basic topology, and completeness of the real numbers; sequences and series; limits, continuity, and derivatives of real-valued functions; sequences and series of functions, and the Riemann integral.

**Prerequisites:** MA 113, MA 114 and MA 215.**Note(s):** Offered fall semester each year and spring semester of even-numbered years.**MA 305 - Introduction to Probability**

Credits: 4

An introduction to the theory of probability and applications of probability in modeling real world phenomena. The goal of this course is to introduce students to the language, ideas, and tools of probability, the science of uncertainty. Probabilistic concepts, derivations, and problem solving are emphasized. Computational tools will also be used to explore and verify theoretical results. Topics include counting methods, random variables, discrete and continuous distributions, mathematical expectation, functions of random variables, joint distributions, and limit theorems.

**Prerequisites:** MA 113 and MA 215.**Note(s):** Normally offered fall semester of even-numbered years.**MA 309 - Elements of Modern Geometry**

Credits: 3

Study of various topics in modern geometry, with emphasis on the axiomatic method.

**Prerequisites:** MA 113 and MA 215.**Note(s):** Normally offered fall semester of even-numbered years. May be repeated for credit with a different topic.**MA 310 - History of Mathematics**

Credits: 3

Study of the development of mathematical ideas.

**Prerequisites:** MA 113 and MA 215.**Note(s):** Normally offered spring semester of odd-numbered years.**MA 311 - Differential Geometry**

Credits: 3

An introduction to differential geometry in a classical setting: the study of  $n$ -surfaces, embedded in Euclidean space.

**Prerequisites:** MA 200, MA 202, and MA 215.**Note(s):** MA 270 recommended. Offered on sufficient demand.**MA 313 - Introduction to Topology**

Credits: 3

Selected topics in topology such as metric spaces, point set topology of Euclidean spaces, introduction to algebraic topology.

**Prerequisites:** MA 113 and MA 215.**Note(s):** Normally offered spring semester of odd-numbered years.**MA 316 - Numerical Algorithms**

Credits: 3

An introduction to using computation to obtain approximate solutions to mathematical problems. A variety of algorithms are studied, as are the limitations of using computational methods. Topics include algorithms for solving equations, systems, and differential equations; approximating functions and integrals; curve fitting; round-off errors, and convergence of algorithms.

**Prerequisites:** MA 111 (or both MA 108 and MA 109), CS 106, and MA 200.**Note(s):** Normally offered fall semester of even-numbered years.**MA 319 - Abstract Algebra I**

Credits: 4

A rigorous introduction to algebra from a modern perspective, focusing on the underlying abstract algebraic structures rather than specific instances of algebraic objects. Students will learn groups, cyclic groups, subgroups and direct products of groups, and permutation groups; rings and ideals; fields; Lagrange's theorem; group homomorphisms and isomorphisms; and normal subgroups and quotient groups.

**Prerequisites:** MA 200 and MA 215.**Note(s):** Offered fall semester each year and spring semester of odd-numbered years.**MA 320 - Abstract Algebra II**

Credits: 3

Selected topics in advanced algebra.

**Prerequisites:** MA 319.**Note(s):** Normally offered spring semester of even-numbered years.**MA 323 - Real Analysis**

Credits: 3

Selected topics in real analysis.

**Prerequisites:** MA 303.**Note(s):** Offered on sufficient demand.

**MA 324 - Complex Analysis**

Credits: 3

Analytic functions, complex integration, complex sequences and series, and conformal mapping.

**Prerequisites:** MA 303.

**Note(s):** Normally offered spring semester of even-numbered years.

**MA 325 - Problem Solving In Mathematics**

Credits: 1

Advanced level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**Prerequisites:** AQR placement.

**Note(s):** During fall semesters, students will have an opportunity to compete in the annual William Lowell Putnam Mathematical Competition. May be repeated for credit. Must be taken S/U.

**MA 325H - Honors: Problem Solving In Mathematics (Jr/Sr)**

Credits: 1

Advanced level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**MA 326H - Honors: Problem Solving**

Credits: 1

Advanced level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

**MA 331 - Dynamical Systems**

Credits: 3

A study of dynamical systems and their application. Topics covered include first-order equations, bifurcation theory, linear systems, phase plane analysis, and chaos. Examples will be considered from problems in medicine and the natural and social science.

**Prerequisites:** MA 270.

**Note(s):** Normally offered fall semester of odd-numbered years.

**MA 351 - Selected Topics in Mathematics**

Credits: 1-4

Topics that complement the established upper level course offerings in mathematics will be selected. Emphasis will be on the nature of mathematical thought.

**Prerequisites:** MA 215.

**MA 371 - Independent Study Math**

Credits: 1-4

Special study in mathematics outside the regular department offerings.

**MA 376 - Senior Seminar in Mathematics**

Credits: 3

Research, discussion, and presentation of selected topics at an advanced level, to provide a capstone experience for the mathematics major; primarily intended for seniors. Senior Seminar in Mathematics - Research, discussion, and presentation of selected topics at an advanced level, to provide a capstone experience for the mathematics major; primarily intended for seniors.

**Prerequisites:** Senior status, MA 215, one 300-level course in Mathematics, in addition to any specific courses required by the instructor.

**Note(s):** Offered spring semester. In exceptional circumstances non-senior students may be permitted to enroll in the course with department approval. This course may be repeated for credit with permission of the department. Fulfills Senior Experience Coda requirement.

**MA 381 - Senior Thesis**

Credits: 3

Optional for mathematics majors. Recommended for those working toward professional careers or graduate study in mathematics, and required for those seeking to satisfy the criteria for departmental honors.

**Prerequisites:** Permission of department.

**Note(s):** Optional for mathematics majors. Recommended for those working toward professional careers or graduate study in mathematics, and required for those seeking to satisfy the criteria for departmental honors.

**MA 382 - Senior Thesis**

Credits: 3

Optional for mathematics majors. Recommended for those working toward professional careers or graduate study in mathematics, and required for those seeking to satisfy the criteria for departmental honors.

**Prerequisites:** Permission of department.

**MA 399 - Internship in Mathematics**

Credits: 1-4

Professional experience at an advanced level for juniors and seniors with substantial academic experience in mathematics. With faculty sponsorship and departmental approval, students may extend their educational experience in pure or applied mathematics. This course may not be used to satisfy the requirements of any major or minor in the department.

**Prerequisites:** Permission of department.

**Note(s):** Not for liberal arts credit.