MATHEMATICS

Courses

Our Courses

MATH 1000. Precalculus. (3 Credits)
In this course, students will be introduced to a rigorous treatment of the mathematics necessary to succeed in calculus. Topics include intervals, equations, inequalities, functions, operations on functions, inverse functions, graphing polynomial functions, exponential and logarithmic functions, trigonometric functions, and identities. This course does not fulfill the mathematical/computational reasoning core requirement.

MATH 1001. Math for Business: Precalculus. (3 Credits)
This course is designed to prepare students in the Gabelli School of Business for Math for Business: Calculus. Topics include inequalities; linear, polynomial, rational, exponential, logarithm and inverse functions and their graphs; distance, lengths, and area of simple regions. This course does not satisfy the mathematical/computation reasoning core requirement.

MATH 1003. Mathematics and Democracy. (3 Credits)
What is the relationship between mathematics and democracy? In this course we explore answers to this question from different perspectives One approach is that members of society must have a certain mathematical literacy for informed participation in their society. It is increasingly the case in our world that people must comprehend and analyze numbers and quantitative information, in complicated contexts, on a regular basis. We'll discuss and look at examples of the numeracy skills needed to evaluate data and information, to analyze statistics, and to understand and formulate quantitative arguments, as well as social justice issues of access to mathematics. We will then explore the contributions of mathematics to the development of democratic systems, looking at voting and the larger question of how a group can best arrive at a decision. Topics may include decision-making strategies, the manipulability of voting systems, fair division and apportionment, and the mathematics of competition. This course should be particularly relevant to students in political science, philosophy, economics, and sociology.
Attribute: MCR.

MATH 1100. Finite Mathematics. (3 Credits)
This course introduces students to topics in mathematics that have real-world applications, include sets and Venn diagrams, counting principles; basic concepts of probability, conditional probability and Bayes' theorem, applications of probability, binomial probability, random variables; elements of statistics, normal distribution; and an overview of mathematics for finance. High school algebra is the only prerequisite.
Attribute: MCR.
Mutually Exclusive: MATH 1108.

MATH 1106. Math for Business: Precalculus. (1 Credit)
A one-credit course for Gabelli students who have not completed Precalculus.

MATH 1108. Math for Business: Finite. (3 Credits)
This course, open to Gabelli School of Business students, introduces fundamental mathematical concepts and techniques arising in business. Topics include linear programming, mathematics of finance, counting techniques, as well as basic concepts of probability and statistics such as conditional probability, Bayes' formula, and binomial and normal distributions. Upon successful completion of this course, students should be able to formulate mathematical models of a range of real-world problems and solve them using some of the above mentioned tools.
Mutually Exclusive: MATH 1100.

MATH 1109. Math for Business: Calculus. (3 Credits)
This course provides business majors with an introduction to differential and integral calculus. Topics include differentiation, integration, and their applications, in particular derivatives of polynomials, rational, exponential and logarithmic functions; curve sketching, optimization problems; and the definite integral. Applications are drawn from business and economics. This course is open only to students in the Gabelli School of Business.
Mutually Exclusive: MATH 1203.

MATH 1198. Honors Business Math. (4 Credits)
Topics covered in this course include elements of multivariable calculus, solutions of systems of linear equations, discrete and continuous probability, and applications to business. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.

MATH 1200. Topics in Finite Mathematics. (1 Credit)
This course covers basic concepts of finite mathematics: counting techniques including Venn diagrams, permutations, combinations, probability, and Bayes' theorem.

MATH 1203. Applied Calculus I. (3 Credits)
This calculus course is designed for students who do not require Calculus 2 or other upper-level math courses as part of their major. Topics include derivatives of polynomial, rational, exponential, and logarithmic functions; curve sketching; and optimization problems.
Attributes: ENVS, MCR, NEUR.
Mutually Exclusive: MATH 1109.

MATH 1204. Applied Calculus II. (3 Credits)
A continuation of MATH 1203. Topics include derivatives of trigonometric functions, methods of integration and applications, calculus of functions of several variables, Lagrange multipliers.
Prerequisite: MATH 1203.

MATH 1205. Applied Statistics. (3 Credits)
This course is designed for students in fields that emphasize quantitative methods. It includes calculus-based preliminary probability material followed by an introduction to basic statistical methods such as estimation, hypothesis testing, correlation, and regression analysis. Examples from a variety of fields and practical experience with statistical software are also provided.
Attribute: ENVS.
Prerequisites: MATH 1203 or MATH 12AB or MATH 12BC.

MATH 1206. Calculus I. (4 Credits)
This calculus course is intended for science and math majors. Topics include limits; continuity; intermediate value theorem; derivatives; mean value theorem; applications such as curve sketching, optimization, related rates, linear approximation, and differentials; antiderivatives; Riemann sums; definite integrals; the Fundamental Theorem of Calculus; substitution rule; inverse functions and their derivatives; and logarithmic and exponential functions. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Attributes: ENVS, MCR, NEUR.

MATH 1207. Calculus II. (4 Credits)
Calculus II is a continuation of the Calculus I course. Topics include inverse trigonometric functions and their derivatives; techniques of integration, such as integration by parts, partial fractions, trigonometric integrals and trigonometric substitutions; improper integrals; volumes of solids using cross sections; sequences and series; convergence and divergence tests; power series; Taylor, Maclaurin series and applications; parametric curves and conic sections; polar coordinates and polar equations of curves; the 3D coordinate system and vectors; dot product and cross product of vectors; equations of lines and planes. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Attribute: MCR.
Prerequisites: MATH 1206 or MATH 12AB or MATH 12BC.

MATH 1700. Mathematical Modelling. (4 Credits)
This course shows how discrete and continuous mathematical models can be built and used to solve problems in many fields. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Attributes: ENVS, MCR, NEUR.
Prerequisites: MATH 1206 or MATH 1207 or MATH 12AB or MATH 12BC.

MATH 1800. Internship. (1 Credit)
Internship.

MATH 1999. Tutorial. (1 Credit)
Independent Study.

MATH 2001. Discrete Mathematics. (4 Credits)
This course introduces students to the language and writing of mathematical proofs in the context of discrete structures. Topics include elementary logic; basic proof techniques such as direct proof, proof by contradiction, contraposition, case division, induction; division, the Euclidean algorithm, modular arithmetic; set theory, relations and equivalence, functions. Additional topics may include cardinality of sets, combinatorics, and graphs. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 1206 or MATH 1207 or MATH 12AB or MATH 12BC.

MATH 2004. Multivariable Calculus I. (4 Credits)
Topics covering in this course include vectors and the three-dimensional coordinates methods of solid geometry, vector-valued functions, functions of several variables, partial derivatives, gradients, Lagrange multipliers, and multiple integrals. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 1207.

MATH 2005. Multivariable Calculus II. (4 Credits)
This is a continuation of MATH 2004. Topics covered in this course include vector fields and their derivatives, multiple integrals, line and surface integrals, and the theorems of Gauss, Green and Stokes. One or more of the following additional topics may be covered, as time permits: differential forms, functions of a complex variable, fluid mechanics, or geometry of surfaces. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 2004.

MATH 2006. Linear Algebra I. (4 Credits)
Topics covered in this course include systems of linear equations, real and complex vector spaces, linear independence, dimension, linear transformations, matrix representations, fundamental theorem of linear algebra, determinants, and eigenvalues. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 1206 or MATH 1207 or MATH 12AB or MATH 12BC.

MATH 2008. Vector Calculus. (4 Credits)
Topics include the algebra and analytic geometry of three-dimensional vectors, tangent lines and arc length of parameterized curves, continuity and differentiability of functions of several variables, tangent planes and area of surfaces, gradients, chain rule, max/min values, Lagrange multipliers, iterated integrals, change of variables in multiple integrals, the theorems of Green and Stokes, and the Divergence Theorem. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Attribute: MCR.
Prerequisite: MATH 1207.
Mutually Exclusive: MATH 2004, MATH 2005.

MATH 2011. Programming for Math and Science. (4 Credits)
This course focuses on Python programming and scripting of algorithms coming from basic linear algebra. Students develop their own implementations that form the basis of many computational methods. The course is accessible to students in mathematics and the physical, social, and computer sciences. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 1206.

MATH 2990. Putnam Problem Solving Seminar. (1 Credit)
A one-credit seminar devoted to solving challenging mathematical problems in preparation for the William Lowell Putnam Mathematical Competition.
Prerequisites: MATH 1206 or MATH 1207 (may be taken concurrently) or MATH 2008 (may be taken concurrently).

MATH 2999. Tutorial. (2 Credits)
Independent Study.

MATH 3001. Linear Algebra II. (4 Credits)
Topics include vector spaces over arbitrary fields, triangular form, Jordan canonical form, inner product spaces, coding theory. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2001 and MATH 2006.

MATH 3002. Differential Equations. (4 Credits)
Topics covered in this course include existence and uniqueness theorems for ordinary differential equations, linear differential equations, power series solutions, Laplace transform and numerical methods. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2004 or MATH 2008.

MATH 3003. Real Analysis. (4 Credits)
This course focuses on analysis on Euclidean spaces. Topics include limits, continuity, uniform continuity, sequences of numbers and functions, modes of convergence, differentiability, Riemann integrability, and associated theorems. Students who have not taken MATH 2004 prior to taking Real Analysis may request permission from the instructor. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2001 and (MATH 2004 or MATH 2008).

MATH 3004. Complex Analysis. (4 Credits)
Topics include complex numbers and mappings, analytic functions, Cauchy-Riemann equations, Cauchy integral theorem, Taylor and Laurent series expansions, residue theory. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2004 or MATH 2008.

MATH 3005. Abstract Algebra I. (4 Credits)
Topics include well ordering and induction, unique factorization, modular arithmetic, groups, subgroups, Lagrange's theorem, normality, homomorphisms of groups, permutation groups, simple groups. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2001 and MATH 2006.

MATH 3006. Probability. (4 Credits)
Topics include discrete and continuous probability models in one and several variables, expectation and variance, limit theorems, applications. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2004 or MATH 2008.

MATH 3007. Statistics. (4 Credits)
Topics include sampling distributions, estimation, testing hypotheses, analysis of variance, regression and correlation, nonparametric methods, time series. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 3006.

MATH 3008. Number Theory. (4 Credits)
Topics include divisibility and related concepts, congruencies, quadratic residues, number theoretic functions, additive number theory, some Diophantine equations. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 2001.

MATH 3009. Mathematics of Finance. (4 Credits)
The market for options, a type of contract in finance, has grown quickly in the past fifty years. In this course we will explore the Nobel Prize-winning Black-Scholes-Merton model for valuing these contracts. We will introduce basic notions of probability (such as Brownian motion) as well as basic notions from finance (such as the No Arbitrage Principle) and use these to derive and solve the Black-Scholes equation. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 3006.

MATH 3010. Scientific Communication. (4 Credits)
In this course, students develop skills in written and oral communication needed to produce scientific articles, monographs, and presentations that are accomplished in both form and content. The course covers both the use of LaTeX to produce work that meets the highest standards of design and typography, and the techniques of writing, organization, and scholarly citation needed to ensure that this work accurately embodies, effectively communicates, and professionally documents the author's scientific thought. Students will learn the ins and outs of generating and using copyright material, and how to present data in forms of pictures, tables, graphs, or schematics. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Attributes: EP3, PPWD.

MATH 3011. Mathematical Imaging. (4 Credits)
In this course, students will learn about the mathematical tools used in digital image processing and analysis. It covers essential mathematical concepts and techniques for image representation, intensity transformation, spatial filtering, and frequency filtering. The course also introduces various models for image enhancement, image degradation, and restoration. If time permits, image segmentation (identifying components of the scene) will also be introduced. To reinforce students' understanding and practical skills, theories will be complemented by computer exercises. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: (MATH 2004 or MATH 2008) and MATH 2006.

MATH 3012. Math of Infinity. (4 Credits)
Topics covered in this course include elementary set and function theory; the notion of counting infinite sets, including Hilbert's infinite hotel; cardinality and infinite cardinals; and Cantor's work on infinite sets. Additional topics may include well-ordered sets and math induction; prime number generators; the Riemann zeta function; logic and meta-mathematics. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.

MATH 3800. Internship. (3 Credits)
Internship.

MATH 3999. Tutorial. (3 Credits)
Independent Study.

MATH 4001. Mathematical Ethics Practicum. (4 Credits)
In this class, which fulfills the Senior Values seminar requirement of the Core Curriculum and serves as a capstone to both the pure and applied tracks of the Mathematics major, students will learn the ethical responsibilities of mathematicians, both as interpreters and as creators of mathematics. The course will combine historical and contemporary case studies with practical training in the skills and disciplines students must master to assume full ownership of their mathematics. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Attributes: EP4, VAL.

MATH 4002. Preparing for Industrial Careers in Mathematics. (2 Credits)
This is an experiential learning course that introduces students to problems arising in industry and the development of solutions using mathematical approaches. Students work in teams on a research problem identified by a community partner from business, industry, or government. This course is intended for students with a strong interest in industrial applications of mathematics and computation, and provides an opportunity to develop mathematical and programming skills. Student success will depend on real-world industry metrics, which include teamwork, effective communication, independent thinking, problem-solving, and deliverables. Students will use mathematics from previous coursework but will also need to find new ideas and learn new techniques to make progress on their problems. Finally, students will grow in their ability to work in a professional setting by preparing oral and written reports for a non-mathematical audience.
Prerequisites: (MATH 2004 or MATH 2008) and MATH 2006.

MATH 4004. Topology. (4 Credits)
Topics include open sets and continuity in metric spaces and topological spaces, subspaces and quotient topologies, compact sets, connected sets. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2001 and (MATH 2004 or MATH 2008).

MATH 4005. Abstract Algebra II. (4 Credits)
Examples and properties of rings and fields. As time permits, examples of algebraic structures that appear in other mathematical disciplines, such as symmetry groups, topological invariants, and cryptography. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisite: MATH 3005.

MATH 4006. Numerical Analysis. (4 Credits)
In this course, students analyze and implement numerical algorithms used to efficiently solve problems coming from science and engineering, such as root finding, systems of equations, approximation of functions, integration, differential equations, and direct and iterative methods in linear algebra. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: (MATH 2004 or MATH 2008) and MATH 2006.

MATH 4009. Topics in Geometry. (4 Credits)
In this course, students focus on the study of Euclidean and non-Euclidean geometries using an axiomatic approach. We study propositions from Euclid's Elements before focusing on more advanced results in Euclidean geometry and their proofs. We follow the history of the parallel postulate, the discovery of non-Euclidean geometry, and the attendant philosophical implications. We build models and prove theorems from incidence, neutral, and hyperbolic geometries. Some properties may be investigated through the use of interactive geometry software. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2004 or MATH 2008.

MATH 4011. Mathematics of AI. (4 Credits)
The course will start with a review of required tools from Linear Algebra and Probability. The course then covers gradient descent optimization, linear regression, logistic regression, neural networks, kernel methods, and infinite-width limits of neural networks. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: (MATH 2004 or MATH 2008) and MATH 2006.

MATH 4020. Differential Geometry. (4 Credits)
This course introduces the geometry of curved spaces in many dimensions, which are the basis of subjects such as Einstein's theory of gravitation. Topics include manifolds, tangent spaces, the Gauss map, the shape operator, curvature, and geodesics. Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: (MATH 2004 or MATH 2008) and MATH 2006.

MATH 4022. Partial Differential Equations. (4 Credits)
This course provides students with an introduction to partial differential equations. Topics include first-order, diffusion, wave, and Laplace equations; Fourier series; Green's functions; and finite difference methods. Partial differential equations are a fundamental tool in physics and find application in machine learning and finance. Note: Four-credit courses that meet for 150 minutes per week require three additional hours of class preparation per week on the part of the student in lieu of an additional hour of formal instruction.
Prerequisites: MATH 2005 or MATH 2008 or (MATH 2006 and MATH 3002).

MATH 4999. Tutorial. (4 Credits)
Independent Study.