MATHEMATICS

Overview and Contact Information

Courses in the Department of Mathematics and Statistics are designed with several goals in mind: to teach the language of the mathematical sciences, to provide a command of powerful mathematical tools, to develop problem-solving skills, to foster the ability to ask questions and make independent discoveries, and to encourage the experience of mathematics as a distinctively rigorous way of knowing.

See Also

- Bio-Mathematical Sciences (http://catalog.mtholyoke.edu/areas-study/biological-sciences)
- Engineering (http://catalog.mtholyoke.edu/areas-study/engineering)
- Dual-Degree in Engineering (http://catalog.mtholyoke.edu/other-programs/other-degree-certificate-programs)

Contact Information

Andrea Foulkes, Chair
Lindsay Woloszyn, Academic Department Coordinator

415A Clapp Laboratory
413-538-2162
https://www.mtholyoke.edu/acad/math

Faculty

This area of study is administered by the Department of Mathematics and Statistics:

Giuliana Davidoff, Robert L. Rooke Professor of Mathematics

Andrea Foulkes, Professor of Mathematics and Statistics

Janice Gifford, Professor of Statistics

Mark Peterson, Professor of Physics and Mathematics on the Alumnae Foundation

Margaret Robinson, Julia and Sarah Ann Adams Professor of Mathematics

Jessica Sidman, Professor of Mathematics on the John Stewart Kennedy Foundation, Teaching Spring Only

Dylan Shepardson, Associate Professor of Mathematics

Timothy Chumley, Assistant Professor of Mathematics

Alanna Hoyer-Leitzel, Assistant Professor of Mathematics

Evan Ray, Assistant Professor of Statistics

Peter Rosnick, Visiting Professor of Mathematics

Sarah-Marie Belcastro, Visiting Lecturer in Mathematics

Carrie Hosman, Visiting Lecturer in Statistics

Thomas Shelly, Visiting Lecturer in Mathematics

Jordan Tirrell, Visiting Lecturer in Mathematics

Nathan Gray, Visiting Instructor in Mathematics

Konstandinos Kotsiopoulos, Visiting Instructor in Mathematics; UMass Teaching Associate

Requirements for the Major

A minimum of 36 credits

MATH-203	Calculus III	4
MATH-211	Linear Algebra	4
MATH-232	Discrete Mathematics	4
MATH-301	Real Analysis	4
MATH-311	Abstract Algebra	4
4 additional credits in mathematics or statistics at the 300 level		4
12 additional credits in mathematics or statistics at the 200 level or above [1,2]		12
Total Credits		36

1. We strongly encourage students to explore topics in applied mathematics and statistics and urge students to begin this before their junior year.
2. With prior approval, a 300-level course that contains substantial mathematical or statistical content in another discipline may be used to fulfill at most 4 of these credits toward the major.

Requirements for the Minor

A minimum of 16 credits:

At least one 200-level course in mathematics	4
At least one 300-level course in mathematics	4
Two additional courses in mathematics or statistics at the 200 level or above	8
Total Credits	16

Additional Specifications

- Students planning a minor in mathematics should consult a member of the department.
- With departmental permission, students who have already completed one 100-level exploration course may elect to enroll in a second exploration course at the 200-level so that it may be counted toward the minor.

Teacher Licensure

Students interested in pursuing licensure in the field of mathematics can combine their course work in mathematics with a minor in education. In some instances course work in the major coincides with course work required for licensure; in other cases, it does not. For specific course requirements for licensure within the major of mathematics, please consult your advisor or the chair of the mathematics department. Further information about the minor in education (http://catalog.mtholyoke.edu/areas-study/psychology-education/#minortext) and the Teacher Licensure program (http://catalog.mtholyoke.edu/areas-study/psychology-education/#teacherlicensuretext) is available in other sections of the catalog, or consult Ms. Lawrence in the psychology and education department.

Licensure also requires a formal application, as well as passing scores on the Massachusetts Test of Educator Licensure (MTEL) in both the literacy component and the subject matter component. Copies of the test

objectives for the MTEL are available in the mathematics department and in the Department of Psychology and Education.

Additional information about the Licensure Program, including application materials, can be found on the Teacher Licensure Program website (https://www.mtholyoke.edu/acad/teach).

Course Advice

Beginning the Study of Mathematics

There are many ways to begin the study of the mathematical sciences at Mount Holyoke College. Students can begin with precalculus, calculus, an introduction to statistics or data analysis, an "explorations" course, or computer science.

If your interests lie in science, economics, or social sciences, calculus is important because it is the language these disciplines use. Students who are planning to take Precalculus or Calculus I are required to complete a brief online self-assessment. The self-assessment is available to all entering students. It is designed so that a student can use it as a learning tool, taking it as many times as they wish. More information is on the department's website (https://www.mtholyoke.edu/acad/math/assessments).

Toward the Study of Calculus

If the online self-assessment or your own mathematics background suggests, you should complete a year-long sequence of MATH-100, followed by MATH-101. The Precalculus course carries 4 credits but does not meet any distribution requirement. Distribution credit will be granted upon successful completion of MATH-101. Precalculus courses taken outside the Mount Holyoke College MATH-100/MATH-101 sequence will not be granted credit nor be approved to satisfy any distribution requirement.

Beginning with Calculus

If you wish to begin with a calculus course, you can take any of the following:

MATH-101	Calculus I	4
MATH-102	Calculus II	4
MATH-203	Calculus III	4

Students who have not studied calculus and who have the necessary precalculus background belong in Calculus I.

Most students who have taken calculus in high school begin with Calculus II. In particular, if you have studied the derivative and its applications and have been introduced to the definite integral, you should take the Calculus Assessment to determine if you are ready to move to Calculus II.

If you have a good knowledge of applications of integration and of transcendental functions, and if you enjoy mathematics, we encourage you to begin your college-level study of calculus with Calculus III (MATH-203). (The study of series is neither required for nor included in Calculus III. Physics and mathematics students will encounter this topic in later courses.)

Beginning the study of calculus beyond Calculus I does not require the advanced placement examination, although the score on this examination is a useful guide. A student with an advanced placement AB score of 3 or less should begin with MATH-101; an advanced placement AB score of 4 or 5 or a BC score of 3 indicates readiness for MATH-102; a grade of 4 or 5 on the BC examination indicates readiness for MATH-203.

Other Beginnings

The "explorations" courses in areas like number theory and geometry (for example, MATH-114, MATH-120) offer another way to begin your study of mathematics. They emphasize mathematics as an art and as a way of seeing and understanding. The exploration courses do not presuppose demonstrated ability for or prior strong interest in mathematics. They intend to awaken interest by demonstrating either the remarkable pervasiveness of mathematics in nature and its power as a tool that transcends disciplines, or its qualities as an art that can fascinate and offer aesthetic pleasure to the participant. Any explorations course can serve as an entry to the further study of mathematics, and even to a minor or a major. Students who wish to go on may follow up with the Laboratory in Mathematical Experimentation (MATH-251) or Discrete Mathematics (MATH-232), among various other possibilities, all of which can be discussed with any member of the department.

A few students begin their study of mathematics with Linear Algebra (MATH-211), Discrete Mathematics (MATH-232), or the Laboratory in Mathematical Experimentation (MATH-251). Linear Algebra is a good choice for students who have a very solid background in high school mathematics and who enjoy abstraction. If you have taken some calculus, and if you enjoy new topics in mathematics, then you might consider either Discrete Mathematics (MATH-232) or the Laboratory in Mathematical Experimentation (MATH-251).

Finally, some students begin their study of mathematical sciences with statistics or computer science. For more information see the sections on statistics (http://catalog.mtholyoke.edu/areas-study/statistics) and computer science (http://catalog.mtholyoke.edu/areas-study/computer-science) in this catalog.

Advice to Students with Special Interests

Actuarial science

Students interested in this area should plan to cover the material that is included in the first two actuarial exams as part of their undergraduate program. This material is included in:

MATH-101	Calculus I	4
MATH-102	Calculus II	4
MATH-203	Calculus III	4
MATH-342	Probability	4
STAT-343	Mathematical Statistics	4
ECON-211	Macroeconomic Theory	4
ECON-212	Microeconomic Theory	4
ECON-215	Economics of Corporate Finance	4

Students are also encouraged to obtain experience through an internship.

Biostatistics, public health, or natural resources

Students interested in these areas should include substantial work in biology, chemistry, geology, and/or environmental studies in their programs.

Economics or business

Many students with these interests choose the special major in mathematics and economics or the special major in statistics and economics.

Engineering

Students interested in engineering often double major in mathematics and physics and/or participate in one of the College's five-year, dual-degree programs with Dartmouth's Thayer School of Engineering, the California Institute of Technology, or the University of Massachusetts (see the Other Degree and Certificate Programs chapter (http://catalog.mtholyoke.edu/other-programs/other-degree-certificate-programs)).

Graduate school

Students preparing for graduate school in mathematics or statistics often participate in an undergraduate research program in the summer after the junior year and continue with an honors thesis in the senior year. For students considering graduate work in mathematics, more than the minimum number of courses for the mathematics major is advisable.

Course Offerings

MATH-100 Precalculus

MATH-100QR Precalculus: 'Problem Solving and Quantitative Reasoning'
Fall. Credits: 4
This course is intended for students who, based on the results of their mathematics assessment and the agreement of the instructor, need to strengthen their quantitative and algebraic skills in order to be ready to progress to further mathematics, science, and economics courses. In this class students learn to translate real problems into mathematics, to solve complex multi-step problems, and to gain confidence in using logarithms, exponents, and trigonometry in different contexts.
Applies to requirement(s): Meets No Distribution Requirement
P. Rosnick
Instructor permission required.
Advisory: Permission of instructor. Send score from math online self-assessment and background information to dshepard@mtholyoke.edu

MATH-101 Calculus I
Fall and Spring. Credits: 4
This course is for students who have not studied calculus and who have the necessary precalculus background. It presents rates of change and their applications, integrals, the fundamental theorem, and modeling of phenomena in the natural and social sciences. All students are required to complete the online self assessment of precalculus skills before the course begins.
Applies to requirement(s): Math Sciences
G. Davidoff, A. Hoyer-Leitzel, P. Rosnick, T. Shelly, The department

MATH-102 Calculus II
Fall and Spring. Credits: 4
Topics include techniques of integration, applications of integration, differential equations, sequences, series, and Taylor series.
Applies to requirement(s): Math Sciences
N. Gray, K. Kotsiopoulos, D. Shepardson, J. Tirrell, The department

MATH-114 Explorations in Number Theory
Not Scheduled for This Year. Credits: 4
We will cover the arithmetic of whole numbers and of prime numbers, in particular, examining some of the earliest questions in mathematics from a modern perspective, finding whole number solutions to equations with several variables, deciding whether or not such solutions exist and if so, determining whether the solution set is finite or infinite. Topics include the theory of 'finite arithmetic,' converting questions about the infinite set of whole numbers to those involving just a small set of primes, using computers to examine problems numerically.
Applies to requirement(s): Math Sciences
G. Davidoff
Advisory: a good grasp of arithmetic

MATH-120 Explorations in Geometry

MATH-120PA Explorations in Geometry: 'The Mathematics of Perspective Drawing'
Spring. Credits: 4
How do we calculate the optimal viewing distance of a painting? If you are drawing a building, how do you decide which lines are parallel and which intersect? In this course students will learn the mathematics of perspective drawing, which answers both questions. We will explore ways to use mathematics to analyze and create art.
Applies to requirement(s): Math Sciences
J. Sidman
Advisory: No prior background in either drawing or mathematics is required.

MATH-158MM Developing Mathematical Ideas: Making Meaning for Operations
Fall. Credits: 2
This course provides opportunities for participants to examine the actions and situations modeled by the four basic operations. The course will begin with a view of young children's counting strategies as they encounter word problems, moves to an examination of the four basic operations on whole numbers, and revisits the operations in the context of rational numbers.
Crosslisted as: X.MATH-401
Applies to requirement(s): Meets No Distribution Requirement
S. Bent
Instructor permission required.
Advisory: For teacher licensure students.
Notes: Half semester.

MATH-158ST Developing Mathematical Ideas: Building a System of Tens
Fall. Credits: 2
Participants will explore the base-ten structure of the number system, consider how that structure is exploited in multi-digit computational procedures, and examine how basic concepts of whole numbers reappear when working with decimals. They will study the various ways children naturally tend to think about separating and combining numbers and what children must understand in order to work with numbers in these ways.
Crosslisted as: X.MATH-400
Applies to requirement(s): Meets No Distribution Requirement
S. Bent
Instructor permission required.
Advisory: For teacher licensure students only.
Notes: Half semester.

MATH-203 Calculus III
Fall and Spring. Credits: 4
Topics include differential and integral calculus of functions of several variables.
Applies to requirement(s): Math Sciences
T. Chumley, N. Gray, A. Hoyer-Leitzel, M. Peterson, T. Shelly
Prereq: MATH-102 or its equivalent.

MATH-211 Linear Algebra
Fall and Spring. Credits: 4
Topics include elements of the theory of matrices and vector spaces.
Applies to requirement(s): Math Sciences
G. Davidoff, N.Gray, M. Robinson, T. Shelly
Prereq: MATH-102 or above.

MATH-232 Discrete Mathematics
Fall and Spring. Credits: 4
Studies some aspects of discrete mathematics. Topics include sets, functions, elementary probability, induction proofs, and recurrence relations.
Applies to requirement(s): Math Sciences
G. Davidoff, M. Robinson, T. Shelly, J. Tirrell
Prereq: MATH-102 or above or COMSC-101.

MATH-251 Mathematical Experimentation: An Introduction to Research in the Mathematical Sciences
Spring. Credits: 4
A selection of projects with a goal of discovery of properties and patterns in mathematical structures. The choice of projects varies from year to year and is drawn from algebra, analysis, discrete mathematics, geometry, applied mathematics, and statistics.
Applies to requirement(s): Math Sciences
Other Attribute(s): Writing-Intensive
J. Tirrell
Prereq: MATH-102 or above.
Advisory: MATH-232 recommended

MATH-295 Independent Study
Fall and Spring. Credits: 1 - 4
The department
Instructor permission required.
Notes: The permission of The department is required for independent work to count towards the major or minor.

MATH-301 Real Analysis
Fall and Spring. Credits: 4
Topics include the real number system, convergence of sequences and series, power series, uniform convergence, compactness and connectedness, continuity, abstract treatment of differential and integral calculus, metric spaces, and point-set topology.
Applies to requirement(s): Math Sciences
G. Davidoff, D. Shepardson
Prereq: MATH-102, MATH-211, and MATH-232.

MATH-302 Complex Analysis
Spring. Credits: 4
Topics include differentiation and integration of functions of a complex variable, the Cauchy integral formula, residues, conformal mapping, and applications to physical science and number theory.
Applies to requirement(s): Math Sciences
M. Robinson
Prereq: MATH-203 and MATH-301 or PHYS-205.
Notes: offered alternate years at Mount Holyoke and Smith Colleges

MATH-309 Topics in Analysis

MATH-311 Abstract Algebra
Fall. Credits: 4
Topics include algebraic structures: groups, rings (including some elementary number theory), fields, and vector spaces.
Applies to requirement(s): Math Sciences
M. Robinson
Prereq: MATH-211 and MATH-232.

MATH-319 Topics in Algebra

MATH-319GT Topics in Algebra: 'Group Theory'
Fall and Spring. Credits: 4
Abstract algebra is the study of the common principles that govern computations with seemingly disparate objects. One way to begin is by studying groups, which are sets with a single operation under which each non-identity element is invertible. Examples include the integers with addition, invertible matrices of size n, permutations of a fixed set, and the symmetries of an object. Our goal is to study a definition of groups that unifies all of the important examples above and more.
Applies to requirement(s): Math Sciences
J. Sidman
Prereq: MATH-211 and MATH-232.
Notes: This course will satisfy the MATH-311 requirement for the mathematics major.

MATH-329GT Topics in Geometry and Topology: 'Graph Theory'
Fall. Credits: 4
Graphs seem simple -- they're just collections of dots connected by curves -- but are very rich structures that arise naturally in applications ranging from traffic signals to social networks. We will examine properties such as isomorphism, connectivity, planarity, and coloring using classic examples such as paths, cycles, trees, complete graphs, and polyhedral graphs. More advanced topics will be determined by student interest and course trajectory.
Applies to requirement(s): Math Sciences
S. Belcastro
Prereq: MATH-211 or MATH-232.

MATH-333 Differential Equations
Spring. Credits: 4
This is an introduction to differential equations for students in the mathematical or other sciences. Topics include first-order equations, second-order linear equations, qualitative study of dynamical systems, and first- and second-order linear partial differential equations.
Applies to requirement(s): Math Sciences
T. Chumley
Prereq: MATH-211.

MATH-339 Topics in Applied Mathematics

MATH-339NA Topics in Applied Mathematics: 'Numerical Analysis'
Fall. Credits: 4
Often in mathematical problems, we can prove that a solution exists, but it is impossible to find that solution analytically (e.g. functions with no antiderivative, but that still have a definite integral). In these situations, we can approximate the mysterious solution using a numerical method. This course covers algorithms and accuracy of numerical methods. Topics include numerical algorithms in Linear Algebra, Curve Fitting, Numerical Differentiation and Integration. Each topic will explore rate and order of convergence as a way of assessing the accuracy of numerical results. There will be a coding component to the course, though no previous coding experience is required.
Applies to requirement(s): Math Sciences
A. Hoyer-Leitzel
Prereq: MATH-301 or MATH-333.

MATH-339PT Topics in Applied Mathematics: 'Optimization'
Spring. Credits: 4
Mathematical optimization involves finding the best solution to a problem from a set of feasible solutions defined by mathematical constraints. It has an elegant theory and applications in fields like management, economics, engineering, and computer science that require decision making under constraints on time or other resources. We will begin by studying linear optimization, including duality, the simplex algorithm, and the geometry of linear programming. Other topics will include discrete optimization, network optimization, and nonlinear optimization.
Applies to requirement(s): Math Sciences
D. Shepardson
Prereq: MATH-211.

MATH-339SP Topics in Applied Mathematics: 'Stochastic Processes'
Spring. Credits: 4
A stochastic process is a collection of random variables. For example, the daily prices of a particular stock are a stochastic process. Topics of this course will include Markov chains, queueing theory, the Poisson process, and Brownian motion. In addition to theory, the course will investigate applications of stochastic processes, including models of call centers and models of stock prices. Simulations of stochastic processes will also be used to compare with the theory.
Applies to requirement(s): Math Sciences
T. Chumley
Prereq: MATH-211 and MATH-342.

MATH-342 Probability
Fall and Spring. Credits: 4
This course develops the ideas of probability simultaneously from experimental and theoretical perspectives. The laboratory provides a range of experiences that enhance and sharpen the theoretical approach and, moreover, allows us to observe regularities in complex phenomena and to conjecture theorems. Topics include: introductory experiments; axiomatic probability; random variables, expectation, and variance; discrete distributions; continuous distributions; stochastic processes; functions of random variables; estimation and hypothesis testing.
Applies to requirement(s): Math Sciences
T. Chumley, M. Peterson
Prereq: MATH-203.

MATH-395 Independent Study
Fall and Spring. Credits: 1 - 8
The department
Instructor permission required.
Notes: The permission of The department is required for independent work to count towards the major or minor.