

# 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

Jessica Sidman, 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, On Leave 2016-2017

Margaret Robinson, Julia and Sarah Ann Adams Professor of Mathematics

Jessica Sidman, Professor of Mathematics

Timothy Chumley, Assistant Professor of Mathematics

Alanna Hoyer-Leitzel, Assistant Professor of Mathematics

Dylan Shepardson, Assistant Professor of Mathematics

Carrie Hosman, Visiting Lecturer in Statistics

Peter Rosnick, Visiting Professor of Mathematics

Thomas Shelly, Visiting Lecturer in Mathematics

Jordan Tirrell, Visiting Lecturer in Mathematics

Amir Kouzehkanani, Visiting Instructor in Statistics

Sara Nunez, Visiting Instructor in Statistics; 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 <sup>1,2</sup>		12
<b>Total Credits</b>		<b>36</b>

- <sup>1</sup> We strongly encourage students to explore topics in applied mathematics and statistics and urge students to begin this before their junior year.
- <sup>2</sup> 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
<b>Total Credits</b>	<b>16</b>

## 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 actual self-assessment is available to all entering students and all students preregistering for Calculus. It is designed so that a student can use it as a learning tool, taking it as many times as she wishes. 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-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

*Instructor permission required.*

### 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*

*D. Shepardson*

*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*

*P. Rosnick, J. Tirrell*

### 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*

*T. Chumley, P. Rosnick, T. Shelly*

### MATH-112 History of Mathematics

### MATH-114 Explorations in Number Theory

*Spring. 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-158EX Developing Mathematical Ideas: Examining Features of Shape

*Not Scheduled for This Year. Credits: 2*

Participants examine aspects of 2-dimensional and 3-dimensional shapes, develop geometric vocabulary, and explore both definitions and properties of geometric objects. The seminar includes a study of angle, similarity, congruence, and the relationships between 3-dimensional objects and their 2-dimensional representations. Participants examine how students develop these concepts through analyzing print and video cases as well as reading and discussing research articles.

*Crosslisted as: X.MATH-402*

*Applies to requirement(s): Meets No Distribution Requirement*

*A. O'Reilly, S. Smith*

*Instructor permission required.*

*Notes: Half semester.*

### MATH-158ME Developing Mathematical Ideas: Measuring Space in One, Two, and Three Dimensions

*Not Scheduled for This Year. Credits: 2*

Participants examine aspects of 2-dimensional and 3-dimensional shapes, develop geometric vocabulary, and explore both definitions and properties of geometric objects. The seminar includes a study of angle, similarity, congruence, and the relationships between 3-dimensional objects and their 2-dimensional representations. Participants examine how students develop these concepts through analyzing print and video cases as well as reading and discussing research articles.

*Crosslisted as: X.MATH-405*

*Applies to requirement(s): Meets No Distribution Requirement*

*A. O'Reilly, S. Smith*

*Instructor permission required.*

*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*

*A. Hoyer-Leitzel, M. Robinson, J. Sidman*

*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*

*T. Chumley, A. Hoyer-Leitzel, T. Shelly, D. Shepardson*

*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, A. Hoyer-Leitzel, M. Robinson, D. Shepardson, 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.***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***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**D. Shepardson**Prereq: MATH-102, MATH-211, and MATH-232.***MATH-302 Complex Analysis***Fall. 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**G. Davidoff**Prereq: MATH-203 and MATH-301 or Intro to Math Methods (PHYS-303/PHYS-200/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**G. Davidoff, M. Robinson**Prereq: MATH-211 and MATH-232.***MATH-319 Topics in Algebra****MATH-327 Advanced Logic***Not Scheduled for This Year. Credits: 4*

This course uses the predicate calculus to present a careful development of formal elementary number theory, and elementary recursion theory, culminating in a proof of Gdel's incompleteness results. It includes some discussion of the philosophical significance of these results for the foundations of mathematics.

*Crosslisted as: PHIL-327**Applies to requirement(s): Humanities**S. Mitchell**Prereq: PHIL-225.***MATH-329 Topics in Geometry****MATH-329TP Topics in Geometry and Topology: 'Topology'***Spring. Credits: 4*

This course is an introduction to point-set topology, which is a fundamental language for much of modern mathematics. One of the goals of topology is to understand what it means for a function to be continuous, first in Euclidean space, and then to generalize the notion of continuity to other spaces. The core topics to be studied include: basic set theory, various interesting topologies, continuous functions, connectedness and compactness. Topics from algebraic topology will be covered if time permits.

*Applies to requirement(s): Math Sciences**J. Sidman**Prereq: MATH-232 and any 300-level math class.***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**A. Hoyer-Leitzel**Prereq: MATH-211.***MATH-339 Topics in Applied Mathematics****MATH-339PT Topics in Applied Mathematics: 'Optimization'***Not Scheduled for This Year. 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.

*Crosslisted as: STAT-334SP**Applies to requirement(s): Math Sciences**T. Chumley**Prereq: MATH-211 and MATH-342.*

**MATH-342 Probability**

*Fall. 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*

*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.*