Mathematics

The mathematics major and minor are administered by the Department of Mathematics and Statistics: Emeritus Professor Cobb; Professors Davidoff, Durfee, Gifford (*chair*), O'Shea (on leave 2009-2010), Peterson, Pollatsek (on leave fall 2009), Robinson (on leave spring 2010); Associate Professor Sidman; Assistant Professors McLeod, Shepardson; Lecturer Morrow, Visiting Instructor Conway.

Contact Persons

Laurie Kamins, *senior administrative assistant*
Janice Gifford, *chair*

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.

Requirements for the Major

Credits

- A minimum of 32 credits
- 20 credits at the 300 level

Courses

- Mathematics:
  - 203, Calculus III
  - 211, Linear Algebra
  - 232, Discrete Mathematics, or 251, Laboratory in Mathematical Experimentation
  - 301, Real Analysis
  - 311, Abstract Algebra
- At least 12 additional credits at the 300 level in mathematics or statistics

Requirements for the Minor

Credits

- A minimum of 16 credits in mathematics at the 200 level or higher

Courses

- At least one of the following:
  - 203, Calculus III
  - 211, Linear Algebra
  - 232, Discrete Mathematics, or 251, Laboratory in Mathematical Experimentation
- At least one 300-level mathematics course

Students planning a minor in mathematics should consult a member of the department.

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 pre-calculus, calculus, an introduction to statistics or data analysis, an "explorations" course, or computer science.

Calculus isn't for everyone, but it is recommended or required for many majors and graduate programs, including economics, statistics, and most pure and applied sciences. Students who are planning to take Pre-calculus or Calculus I are required to complete a brief self-assessment on pre-calculus skills. Sample questions, with answers, are available on the department's Web page, *http://www.mtholyoke.edu/acad/math.* 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, and getting pointers to appropriate review materials for the questions she misses. More information is on the department's Web page.

Toward the Study of Calculus. If your interests lie in science, economics, or social sciences,

calculus is important because it is the language these disciplines use. If the assessment test or your own mathematics background suggests, you should consider a year-long sequence of Math 100, Pre-calculus, followed by Math 101, Calculus I. The Pre-calculus course carries 4 credits but does not meet any distribution requirement. Distribution credit will be granted upon successful completion of Math 101, Calculus I. Pre-calculus 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 one of the following: Mathematics 101, Calculus I; Mathematics 202, Calculus II; or Mathematics 203, Calculus III.

Students who have not studied calculus and who have the necessary pre-calculus background belong in Calculus I. Some sections of Calculus I differ significantly from traditional high school calculus. Unlike many high school courses, ours emphasize not only technical skills but also the concepts of calculus, the contexts in which the mathematical ideas arise, and realistic applications. Mastering the subject at this deeper level can be hard work, but the rewards are great, as students acquire meaningful, practical knowledge. It has been our experience that students who "start over," in order to ease the transition into college, initially may have more difficulty in Calculus I than beginners. However, students who take Calculus I expecting and welcoming new ideas have found it rich and rewarding.

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 will be prepared for 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 (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 101 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 consider Mathematics 101, Calculus I; an advanced placement AB score of 4 or 5 or a BC score of 3 indicates readiness for 202; a grade of 4 or 5 on the BC examination indicates readiness for 203.

Other Beginnings. The "explorations" courses in algebra, number theory, geometry, fractals and chaos, and cryptology (110, 114, 120, 125, 139) 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 special talent 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 (251), among various other possibilities, all of which can be discussed with any member of the department. At least two and usually three of these exploration courses are offered each year.

A few students begin their study of mathematics with Linear Algebra (211), Discrete Mathematics (232), or the Laboratory in Mathematical Experimentation (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 the Discrete Mathematics or the Laboratory in Mathematical Experimentation (251).

Finally, some students begin their study of mathematical sciences with statistics or computer science. For more information see the sections on statistics and computer science in this catalogue.

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 Calculus I (Mathematics 101), Calculus II (Mathematics 202), Calculus III (Mathematics 203), Probability (Statistics 342), and Mathematical Statistics (Statistics 343), along with Macroeconomic Theory (Economics 211), Microeconomic Theory (Economics 212), and Economics of Corporate Finance (Economics 215). 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).

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.

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. For information about the requirements for the minor in education, please consult "Teacher Licensure" in the Other Degree and Certificate Programs chapter and 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. Licensure application information and materials are available in the Department of Psychology and Education.

Admission Units

Prerequisites for introductory courses are listed in terms of admission units. An admission unit is a year of high school mathematics, beginning with Algebra I (usually taken in grade nine).

Course Offerings

100f Precalculus
This course is intended for students who, based on the results of their precalculus assessment and the agreement of the instructor, need to strengthen their quantitative and algebraic precalculus skills in order to be ready to progress to calculus. Features the study of functions, including trigonometric functions, the exponential function, and logarithms, and the phenomena they model.
Does not meet a distribution requirement
J. Sidman
Permission of instructor. Send score from math online self-assessment and background information to jsidman@mtholyoke.edu.; 4 credits

101fs Calculus I
Students who have not studied calculus and who have the necessary precalculus background belong in Calculus I. Because some sections of Calculus I differ significantly from traditional high school calculus, it has been our experience that that students who "start over," in order to ease the transition into college, initially may have more difficulty in Calculus I than beginners. However, students who take Calculus I expecting and welcoming new ideas have found it rich and rewarding. Please read the "Beginning the Study of Mathematics" section.
This course presents rates of change and their applications, integrals, the fundamental theorem, and modeling of phenomena in the natural and social sciences.
Meets Science and Math II-A requirement
M. Robinson, D. Shepardson, M. Conway, The department
4 credits

110s Explorations in Algebra
High school algebra is essentially the study of the laws that govern the system of numbers we use for ordinary arithmetic. This course focuses on certain of these laws and studies the systems, called "groups," governed by them. Groups have beautiful properties and describe many phenomena: crystallography, graphic art, matrix algebra, counting, nuclear physics, codes, and more. The course studies the group laws and their consequences, as well as many examples of systems satisfying these laws.
Meets Science and Math II-A requirement
H. Pollatsek
enrollment limited; 4 credits

***114 Explorations in Number Theory**
Studies basic mathematical structures using as models symmetries of plane figures, the ordinary integers, and other number systems. Using examples to uncover patterns that help reveal and explain relationships. Solving simple equations in these new settings quickly brings students into contact with some intriguing problems being studied by contemporary mathematicians.
Meets Science and Math II-A requirement
The department
Prereq. 4 admission units or permission of instructor; enrollment limited; 4 credits

***120 Explorations in Geometry**
The system of geometry devised by the ancient Greeks was immutable until the nineteenth century, when it was put in a broader framework better able to accommodate the varied interests of physical science and mathematics. In this course, we study geometry as it developed historically, from the time of Pythagoras to the recent past.
Meets Science and Math II-A requirement
The department
4 credits

***125f Explorations in Fractals and Chaos**
An introduction to fractals and chaos. Topics selected from the following: self-similar fractals, fractal dimension, iteration, the Feigenbaum diagram, Julia sets and the Mendelbrot set, strange attractors and applications.
Meets Science and Math II-A requirement
The department
enrollment limited; 4 credits

139f Explorations in Cryptology
Cryptology is the study of secret codes. Since the beginning of civilization to the present day, encrypted messages have played an important role in war, espionage, diplomacy, and business. This course examines the history of these codes and their mathematical basis.
Meets Science and Math II-A requirement
A. Durfee
Prereq. 4 admission units or permission of the instructor; 4 credits

***160f Introductory Seminar: Mathematics and Music**
(First-year seminar; Same as Music 114-02)
For centuries people have explored the connections between mathematics and music. Sounds are waves, and pleasant-sounding musical intervals are simple fractions. Keyboard instruments are tuned following both regular and slightly irregular mathematical rules. Bells in change ringing follow simple patterns. Some musical pieces can be played both backwards and forwards. On the other hand, aesthetics are paramount in music, yet also play a part in mathematics. This course will explore these ideas.
Meets Science and Math II-A requirement
A. Durfee
Prereq. fy or permission of instructor; 4 credits

201f Examining the ideas of Geometry and Measurement
(Same as Education 201-01)
Does not meet a distribution requirement
J. Bodner Lester
See Education 201f; 4 credits

202fs Calculus II
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 will be prepared for Calculus II. Please read the "Beginning the Study of Mathematics" section.
Topics include techniques of integration, applications of integration, differential equations, sequences, series, and Taylor series.
Meets Science and Math II-A requirement
J. Sidman, J. McLeod, The department
4 credits

203fs Calculus III
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. Please read read the "Beginning the Study of Mathematics" section.
Topics include differential and integral calculus of functions of several variables.
Meets Science and Math II-A requirement
G. Davidoff, The department
4 credits

211fs Linear Algebra
Topics include elements of the theory of matrices and vector spaces.
Meets Science and Math II-A requirement
M. Robinson, The department
Prereq. any 100-level mathematics course; 4 credits

232s Discrete Mathematics
Studies some aspects of discrete mathematics. Topics include sets, functions, elementary probability, induction proofs, and recurrence relations.
Meets Science and Math II-A requirement
The department
Prereq. any 100-level mathematics or computer science course, or permission of instructor; 4 credits

251fs Laboratory in Mathematical Experimentation
(Writing-intensive course) Offers mathematics as a laboratory science. After a short introduction to the computer, uses hand and computer computation to explore mathematical ideas. Directs laboratory projects toward 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, and statistics.
Meets Science and Math II-A requirement
J. McLeod, The department
Prereq. 4 credits from the department or permission of instructor; 4 credits

295fs Independent Study
Does not meet a distribution requirement
Prereq. soph, permission of department; 1-4 credits

301s Real Analysis
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.
Meets Science and Math II-A requirement
The department
Prereq. Mathematics 251 or permission of instructor; 4 credits

***302f Complex Analysis**
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.
Meets Science and Math II-A requirement
The department
Prereq. Mathematics 203 or Physics 303; offered alternate years at Mount Holyoke and Smith Colleges; 4 credits

***309 Topics in Analysis**
Topics to be announced
Meets Science and Math II-A requirement
The department
Prereq. Mathematics 203 and 211, or permission of instructor; 4 credits

311f Abstract Algebra
Topics include algebraic structures: groups, rings (including some elementary number theory), fields, and vector spaces.
Meets Science and Math II-A requirement
G. Davidoff
Prereq. Mathematics 211 and another 200-level mathematics course; 4 credits

319s Topics in Algebra
To be announced
Meets Science and Math II-A requirement
H. Pollatsek
Prereq. Mathematics 311 or permission of instructor; 4 credits

***322f Differential Geometry**
We will study the differential geometry of curves and surfaces. In particular, we will use calculus and linear algebra to develop rigorous notions that correspond to our intuitive understanding of smoothness and curvature.
Meets Science and Math II-A requirement
The department
Prereq. Mathematics 203, 211. Mathematics 301 helpful but not necessary; 4 credits

***324s Methods of Applied Mathematics**
(See Physics 324s)
Does not meet a distribution requirement
The department
4 credits

327f Advanced Logic
(See Philosophy 327f)
Meets Humanities I-B requirement
S. Mitchell
4 credits

***329s Topics in Geometry and Topology**
This is an introduction to point-set topology (also referred to as general topology). Point-set topology is one branch of the much broader area, topology. It is concerned with the study of properties of abstract topological spaces and structures related to such spaces. The material covered in this course will provide the common foundation for courses in algebraic topology, geometric topology, and differential topology. The core topics to be studied include: basic set theory, various interesting topologies, continuous functions, connectedness and compactness, separation axioms, countability axioms, nets and filters.
Meets Science and Math II-A requirement
The department
Prereq. Mathematics 203, one of Mathematics 211 or 251, or permission of the instructor; this course may be repeated for credit; 4 credits

333s Differential Equations
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.
Meets Science and Math II-A requirement
The department
Prereq. Mathematics 202; 4 credits

339f Topics in Applied Mathematics: Fourier and other Eigenfunction Expansions
This course is an introduction to one of the most powerful methods of applied mathematics, eigenfunction expansions. The most familiar example is the Fourier series, and it is also perhaps the most useful because of the existence of the Fast Fourier Transform algorithm (FFT). The course will aim to make this theory useful, and in particular to develop a good working knowledge of the FFT and its associated lore, called spectral methods. Other eigenfunction expansions will include the spherical harmonics for problems on the sphere. Since these expansions are infinite series, the theory inevitably raises questions of convergence and what is called more generally functional analysis.
Meets Science and Math II-A requirement
M. Peterson
Prereq. Mathematics 203 and 211 or permission of instructor; 4 credits

342f Probability
(See Statistics 342f)
Meets Science and Math II-A requirement
G. Cobb
Prereq. Mathematics 203; 4 credits

395fs Independent Study
Does not meet a distribution requirement
Prereq. jr, sr, permission of department; 1-8 credits