STATISTICS

Overview and Contact Information
Statistics is used in most professions, in most sectors of the economy, and in a great many academic areas. Each year some students enter graduate programs in statistics, or in allied fields (business, economics, education, or psychology). Many students enter the job market and later pursue advanced degrees.

Contact Information
Dylan Shepardson, Chair
Connell Heady, Academic Department Coordinator
415A Clapp Laboratory
413-538-2162
https://www.mtholyoke.edu/acad/math

Learning Goals
The program in the Department of Mathematics and Statistics is designed with several learning goals in mind:

• To teach the language of the statistical sciences.
• To provide a command of powerful statistical tools.
• To foster an ability to ask questions and to make independent discoveries.
• To encourage the experience of statistics as a distinctively rigorous way of knowing.

In addition, especially through the statistics offering, the rich interplay between an applied context and statistical models in working with numerical data is an area of particular emphasis.

Faculty
This area of study is administered by the Department of Mathematics and Statistics:
Margaret Robinson, Julia and Sarah Ann Adams Professor of Mathematics
Jessica Sidman, Professor of Mathematics on the John Stewart Kennedy Foundation, Teaching Fall Only
Dylan Shepardson, Robert L. Rooke Associate Professor of Mathematics
Chassidy Bozeman, Clare Boothe Luce Assistant Professorship in Mathematics
Timothy Chumley, Assistant Professor of Mathematics
Alanna Hoyer-Leitzel, Assistant Professor in Mathematics
Lidia Mrad, Assistant Professor of Mathematics
Marie Ozanne, Clare Boothe Luce Assistant Professorship in Statistics
Shan Shan, Assistant Professor of Statistics, Teaching Spring Only
Laurie Tupper, Assistant Professor of Statistics
Peter Rosnick, Visiting Professor of Mathematics
Victoria Day, Visiting Lecturer in Mathematics

Samantha Kirk, Visiting Lecturer in Mathematics
Amy Nussbaum, Visiting Lecturer in Statistics
Pramesh Subedi, Visiting Lecturer in Statistics
Derek Young, Visiting Lecturer in Mathematics

Requirements for the Major
A minimum of 36 credits:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH-101</td>
<td>Calculus I</td>
<td></td>
</tr>
<tr>
<td>MATH-102</td>
<td>Calculus II</td>
<td></td>
</tr>
<tr>
<td>MATH-203</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH-211</td>
<td>Linear Algebra</td>
<td>4</td>
</tr>
<tr>
<td>STAT-140</td>
<td>Introduction to the Ideas and Applications of Statistics</td>
<td></td>
</tr>
<tr>
<td>STAT-242</td>
<td>Intermediate Statistics</td>
<td>4</td>
</tr>
<tr>
<td>STAT-340</td>
<td>Applied Regression Methods</td>
<td>4</td>
</tr>
<tr>
<td>MATH-342</td>
<td>Probability</td>
<td>4</td>
</tr>
<tr>
<td>STAT-343</td>
<td>Mathematical Statistics</td>
<td>4</td>
</tr>
<tr>
<td>12 additional credits in mathematics or statistics at the 200-level or above</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td>36</td>
</tr>
</tbody>
</table>

1 A 300-level course that contains substantial mathematical or statistical content in another discipline may be used to fulfill at most 4 credits toward the major with prior departmental approval.

Requirements for the Minor
A minimum of 16 credits:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least one 200-level course in statistics</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>At least one 300-level course in statistics</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Two additional courses in mathematics or statistics at the 200 level or above</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

Additional Specifications
Substitutions are possible with the permission of the department. Students planning a minor in statistics should consult one of the statistics advisors.

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.

Course Advice
Beginning the Study of Statistics
A natural way to begin if you have not studied statistics is with STAT-140, Introduction to the Ideas and Applications of Statistics.
A 200-level course in statistics is a good choice if you have taken an advanced placement statistics course or have taken the equivalent of a 100-level statistics course.

**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 (MATH-101), Calculus II (MATH-102), and Mathematical Statistics (STAT-343), along with Macroeconomic Theory (ECON-211), Microeconomic Theory (ECON-212), and Economics of Corporate Finance (ECON-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, or 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 statistics or mathematics often participate in an undergraduate research program in the summer after the junior year and continue with an honors thesis in the senior year. Students considering graduate work in statistics at the level of a Ph.D. are encouraged to include abstract algebra and especially MATH-301.

**Teaching certification**
Students interested in pursuing certification for middle school or secondary school should major in mathematics rather than statistics. However, there is increasing emphasis on statistics in secondary school, and any of the applied courses would provide good preparation.

**Course Offerings**

**STAT-140 Introduction to the Ideas and Applications of Statistics**
*Fall and Spring. Credits: 4*
This course provides an overview of statistical methods, their conceptual underpinnings, and their use in various settings taken from current news, as well as from the physical, biological, and social sciences. Topics will include exploring distributions and relationships, planning for data production, sampling distributions, basic ideas of inference (confidence intervals and hypothesis tests), inference for distributions, and inference for relationships, including chi-square methods for two-way tables and regression.

*Advisory: 2 years of high school algebra*

*Prereq: Any 100-level mathematics or statistics course.*

**STAT-240 Elementary Data Analysis and Experimental Design**
*Not Scheduled for This Year. Credits: 4*
A fundamental fact of science is that repeated measurements exhibit variability. The course presents ways to design experiments that will reveal systematic patterns while "controlling" the effects of variability and methods for the statistical analysis of data from well-designed experiments. Topics include completely randomized, randomized complete block, Latin Square and factorial designs, and their analysis of variance. The course emphasizes applications, with examples drawn principally from biology, psychology, and medicine.

*Applies to requirement(s): Math Sciences*

*The department*

*Prereq: Any 100-level mathematics or statistics course.*

**STAT-241 Methods in Data Science**
*Not Scheduled for This Year. Credits: 4*
This course introduces methods in data science, including exploring problems, developing and implementing possible data analytic solutions and interpreting findings. Statistical programming and computational reasoning are emphasized. Topics include data visualization, data manipulation, data analysis and presentation. Reproducible research methods are explored and case studies are emphasized.

*Applies to requirement(s): Math Sciences*

*The department*

*Prereq: STAT-140 and MATH-101.*

**STAT-242 Intermediate Statistics**
*Fall and Spring. Credits: 4*
In this course, students will learn how to analyze data arising from a broad array of observational and experimental studies. Topics covered will include exploratory graphics, description techniques, the fitting and assessment of statistical models, hypothesis testing, and communication of results. Specific topics may include multiple regression, ANOVA, and non-linear regression. Statistical software will be used.

*Applies to requirement(s): Math Sciences*

*A. Nussbaum, M. Ozanne, S. Shan, P. Subedi, L. Tupper*

*Prereq: STAT-140 or equivalent.*

**STAT-244 Intermediate Topics in Statistics**

**STAT-244NF Intermediate Topics in Statistics: ‘Infectious Disease Modeling’**
*Fall. Credits: 4*
Infectious disease has plagued humanity since time immemorial. Statistical models serve a critical role in improving understanding of the progression and proliferation of infection in a population, as well as the impact of interventions in stopping the spread of disease. In this course, we will explore regression and compartmental model-based approaches, which will be motivated by some of the most impactful epidemics and pandemics in recent history, including HIV/AIDS, Ebola, Zika, and COVID-19. R statistical software will be used.

*Applies to requirement(s): Math Sciences*

*M. Ozanne*

*Prereq: STAT-140.*
STAT-244NP Intermediate Topics in Statistics: 'Nonparametric Statistics'
Spring. Credits: 4
The methods taught in traditional statistics courses are based on assumptions that are often not satisfied by real data sets. In this course we will learn about approaches that require fewer assumptions, known as nonparametric methods. After taking this course, students will be able to examine assumptions for different approaches to statistical inference, compare nonparametric statistical tests such as sign and Wilcoxon tests to their parametric equivalents, and implement nonparametric approaches using R. In addition, the course will incorporate computational techniques for statistical analysis, including simulation, permutation tests, and bootstrapping.
Applies to requirement(s): Math Sciences
A. Nussbaum
Prereq: STAT-140.
Advisory: Students should have experience with the programming language R.

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

STAT-340 Applied Regression Methods
Fall. Credits: 4
This course includes methods for choosing, fitting, evaluating, and comparing statistical models; introduces statistical inference; and analyzes data sets taken from research projects in the natural, physical, and social sciences.
Applies to requirement(s): Math Sciences
L. Tupper
Prereq: MATH-211 and STAT-242.

STAT-343 Mathematical Statistics
Spring. Credits: 4
This course is an introduction to the mathematical theory of statistics and to the application of that theory to the real world. Topics include probability, random variables, special distributions, introduction to estimation of parameters, and hypothesis testing.
Applies to requirement(s): Math Sciences
M. Ozanne
Prereq: MATH-102 and MATH-342.

STAT-344 Seminar in Statistics and Scientific Research

STAT-344CC Seminar in Statistics and Scientific Research: 'Statistical Consulting and Communication'
Spring. Credits: 4
John Tukey once said “the best thing about being a statistician is that you get to play in everyone’s backyard” — but when do statisticians learn how to play nice with others? In Statistical Consulting and Communication, students will implement techniques and methods they have learned elsewhere while simultaneously developing skills for communicating results to peers, collaborators, and clients, including best practices for reproducible research, technical writing, and public speaking. Furthermore, students will learn how to respond to questions commonly asked of statistical consultants, such as study design, sample size computations, and dealing with missing data. Finally, students will consider several aspects of ethics in statistics, including questions on informed consent and data manipulation.
Applies to requirement(s): Math Sciences
Other Attribute(s): Speaking-Intensive, Writing-Intensive
A. Nussbaum
Prereq: A 200-level statistics course.
Advisory: Students should have experience with the programming language R.

STAT-344SM Seminar in Statistics and Scientific Research: 'Survey Sampling'
Not Scheduled for This Year. Credits: 4
In this course, students will explore statistical techniques for designing and analyzing complex survey designs. Sample surveys are used to obtain data on demography, health, and development; to measure attitudes and beliefs; to estimate natural resources; to evaluate the impact of social programs; along with many other uses. The proper design and analysis of these surveys is crucial to their utility. We will cover topics including survey design, ratio estimation, regression estimation, poststratification, imputation, and survey error. We will also make frequent use of real (and often messy) survey data through assignments and projects. Background should include hypothesis testing, regression modeling, and estimation.
Applies to requirement(s): Math Sciences
The department
Prereq: STAT-340.

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