MATHEMATICS AND STATISTICS

haverford.edu/mathematics

The courses in the Department of Mathematics and Statistics aim to:

- promote rigorous thinking in a systematic, deductive, intellectual discipline.
- help students identify and articulate mathematical and statistical problems that they encounter, both in formal academic work and elsewhere.
- foster technical competence in mathematics and statistics as an aid to the better comprehension of the physical, biological, and social sciences.
- guide and direct majors toward an interest in research in the mathematical and statistical sciences.

LEARNING GOALS

Students taking courses in the Department of Mathematics and Statistics will think rigorously and systematically both within the context of the discipline and in its applications—and, ideally, throughout the liberal arts curriculum. Students will learn to identify and articulate mathematical problems that they encounter, both in mathematics and in other disciplines. Students will develop skills necessary to engage these problems within a mathematical and/or statistical framework. Finally, students will learn how to communicate their mathematical and statistical findings to a variety of audiences.

CURRICULUM

Mathematics majors take a three-year core sequence of courses in calculus, linear algebra, abstract algebra, and analysis, designed to provide a foundation for further study in the major areas of modern mathematics. Students with substantial advanced placement may complete this sequence by the end of their sophomore year. Students who have completed the core sequence may take advanced courses in algebra, analysis, topology, or other special topics.

Mathematics courses for majors fall into six general categories:

Preliminary Calculus
This category includes MATH 105, 118, or advanced placement. These are not listed among the requirements, but are of course prerequisites for all subsequent courses in mathematics.

Intermediate Calculus/Linear Algebra
This category includes MATH 215, 121 or 216. These courses are taught for the benefit of both majors and non-majors, but are the real "introduction" to math for most majors.

Core Major Courses
This category includes MATH 317-318 (Analysis) and MATH 333-334 (Algebra). These courses are the "cornerstone" of the major, introducing many important ideas in which modern mathematics is based, and also sharpening students' skills in mathematical discourse (i.e., careful statements of definitions, theorems, proofs).

Intermediate Electives

- MATH 203 (Statistical Methods and Their Applications)
- MATH 204 (Differential Equations)
- MATH 210 (Linear Optimization and Game Theory)
- MATH 218 (Probability)
- MATH 222 (Introduction to Scientific Computing)
- MATH/CMSC 235 (Information and Coding Theory)
- MATH 286 (Applied Multivariate Statistical Analysis).

These courses are designed for both majors and non-majors, and provide majors an excellent opportunity to explore interests outside the core sequence. Students can expect at least two electives at this level to be offered most semesters. We coordinate with Bryn Mawr so that if a topic is not offered in a given year at Haverford, it may be offered at Bryn Mawr.

Advanced Electives:

- MATH 328 (Mathematical Statistics)
- MATH 335-336 (Topology)
- MATH/CMSC 340 (Analysis of Algorithms)
- MATH/CMSC 345 (Theory of Computation)
- MATH 390 (Advanced Topics in Algebra)
- MATH 391 (Advanced Topics in Geometry and Topology)
- MATH 392 (Advanced Topics in Analysis)

- MATH 394 (Advanced Topics in Discrete Math and Computer Science)
- MATH 395 (Advanced Topics in Combinatorics)
- MATH 396 (Advanced Topics in Probability and Statistics)
- MATH 397 (Advanced Topics in Applied Mathematics)

Courses at this level are very important for students planning to go to graduate school in mathematics or related fields. The department typically offers five to six courses at this level per year.

Other Courses:

- MATH 399 (Senior Seminar): a required year-long group seminar for seniors that offers advice, support, and practice in preparing the senior paper and oral presentation.
- MATH 400 (Senior Research): a required year-long course for seniors that involves independent work with their senior thesis advisor.
- MATH 460 (Teaching Assistantship in Mathematics): a half-credit course, in which students work closely with a single faculty member in a single course at the 100 or 200 level, offering various kinds of classroom support including problem sessions, review, tutoring, and laboratory assistance. Very good experience for students considering teaching as a career. Open to junior and senior majors by invitation, and may be taken at most twice. Does not count toward the major.

MAJOR REQUIREMENTS

- MATH 215, and either MATH 121 or MATH 216.
- MATH 317 and 333, and one of MATH 318 or 334.
- Four additional electives in mathematics or approved related courses at the 200 level or higher. At least one of these must be at the 300 level. (Note: MATH 399, MATH 400, MATH 460, and MATH 480 do not count toward this requirement.)
- The senior seminar, fall and spring.
- A senior paper and oral presentation.

We strongly advise students planning graduate study in mathematics or related fields to take additional courses at the 300 level. Majors may substitute equivalent courses in mathematics at Bryn Mawr College for any requirement, subject to advisor approval.

MINOR REQUIREMENTS

Mathematics minors take the same core sequence as do the majors, though not necessarily to the same depth, followed by a selection of electives tailored to the student's interest. Statistics minors take a separate core sequence in probability and statistics, with later flexibility in pursuing either a more applied or a more theoretical track.

Mathematics Minor Requirements

- MATH 215 (Linear Algebra) and either MATH 121 (Multivariable calculus) or MATH 216 (Advanced Calculus).
- MATH 317 (Analysis I) and MATH 333 (Algebra I).
- Two additional electives in mathematics at the 200 level or higher.

Minors may substitute equivalent courses in mathematics at Bryn Mawr College for any requirement, subject to advisor approval.

Statistics Minor Requirements

- One of the following courses (Introduction to Statistics): STAT 203, ECON 204, PSYC 200, SOCL 215
- STAT 286 (Applied Multivariate Statistical Analysis)
- MATH 218 (Probability)
- MATH 215 (Linear Algebra)
- MATH 121 or MATH 216 (Multivariable Calculus)
- One of the following:
  - STAT 328 (Mathematical Statistics)
  - STAT 396 (Advanced Topics in Probability and Statistics)
  - ECON 304 (Econometrics)
  - SOCL 320 (Advanced Quantitative Methods for Sociologists).

Options for the Statistics Minor

- A *math minor* can also be a statistics minor. If a student wants to be a math minor and a statistics minor, the following courses: STAT 203, ECON 204, MATH 218, STAT 286, STAT 328 and STAT 396, cannot be counted to satisfy both the math minor and statistics minor.
- A *math major* can also be a statistics minor. If a student wants to be a math major and a

statistics minor, the following apply:
  - STAT 203, ECON 204 and STAT 286 cannot be counted to satisfy both the math major and statistics minor requirement.
  - At most one of the following courses can be counted to satisfy both the math major and statistics minor: MATH 218, STAT 328 and STAT 396.
- *Math majors with economics concentration*: If a math major wants to be an econ concentrator and a statistics minor, MATH 218, STAT 286, STAT 328 and STAT 396 cannot be counted toward both the economics concentration and the statistics minor.
- *Economics majors with math concentration*: If an economics major wants to be a math concentrator and also a statistics minor, the following apply:
  - MATH 218, STAT 286, STAT 328 and STAT 396 cannot be counted to satisfy both the stat minor and the math concentration requirement.
  - ECON 304 cannot be counted toward the statistics minor. (ECON 304 is required by the economics major.)

For further information about the statistics minor, please see the PDF supplement on the mathematics website, or contact the minor coordinator.

SENIOR PROJECT

A senior paper is written by each major in close coordination with a faculty member. The senior paper is a year-long research project that includes both written thesis and oral presentation. All seniors take a year-long senior seminar to support the senior paper. In the seminar, students learn how to use library resources, how to compose and present a poster for a poster session, and take turn presenting portions of their senior papers to each other to develop their skills in constructing and giving oral presentations.

In the fall of the senior year, the student begins to focus on a topic (sometimes an interesting theorem, other times building a mathematical model or analyzing a data set) and works through the material with the faculty advisor. The student completes a detailed thesis proposal, a poster presentation and a "mini-paper." In the spring, the student develops a core fragment of the thesis, the first draft, the second draft, and the final draft of the thesis, and concludes by presenting the thesis to faculty and fellow students.

Senior Project Learning Goals

Our students will engage with advanced content and techniques in pure mathematics, applied mathematics and statistics. They will gain ownership of the process and material through understanding the content and the details of the problem they are investigating, constructing illustrative examples, carrying out novel computations or carefully analyzing a data set. Our students will write clear, careful and correct mathematics/statistics, from precise definition or description of a model to rigorous proofs or well-supported analyses. They will develop an oral presentation that highlights the central ideas of their thesis work at a level appropriate for an audience in the mathematical/statistical sciences.

Senior Project Assessment

The grade for the senior thesis is determined by the following:
- Level of engagement with advanced mathematics or statistics.
- Level of ownership of the material and of the writing process.
- Adherence to professional standards of written mathematics and statistics.

The grade for the senior seminar is determined by the following:
- Completing all the assignments in accordance with the assignment description.
- Meeting deadlines for each assignment.
- Whether easily discernible progress has been made from one assignment to another.
- Participating.
- Quality of the poster presentation.
- Quality of the thesis presentation.
- Quality of the final thesis.

CONCENTRATIONS AND INTERDISCIPLINARY MINORS

Mathematics majors can pursue four areas of concentration:

Computer Science (more theoretical)

It may come as a surprise to some that many of the fundamental questions in computer science (including the famous P versus NP problem) are in essence mathematical questions. Conversely, some of the deepest foundational questions about the nature of mathematics (such as: what constitutes a proof?) are inherently

computational in nature. Computers have also become a powerful tool in mathematical research and its applications, both theoretical and experimental. A full understanding of their capability and potential can only be realized by formal coursework in computer science. The concentration is open to math or physics majors.

Scientific Computing (more applied)
Many disciplines in the natural and social sciences include a significant sub-discipline that is explicitly computational. Examples include astronomy, biology, chemistry, economics, and physics. In some fields, such as biology, the use of computation has become so widespread that basic literacy in computation is increasingly important and may soon become required. The Concentration in Scientific Computing gives students an opportunity to develop a basic facility with the tools and concepts involved in applying computation to a scientific problem, and to explore the specific computational aspects of their own major disciplines.

Mathematical Economics (for majors interested in applying their skills to economic problems)
Mathematics and economics are complementary disciplines. Most branches of modern economics use mathematics and statistics extensively, and some important areas of mathematical research have been motivated by economic problems. Economists and mathematicians have made important contributions to each other's disciplines. Economist Kenneth Arrow, for example, did path-breaking work in the field of mathematical optimization; and in 1994 mathematician John Nash was awarded the Nobel Prize in economics for introducing a theory of equilibrium in non-cooperative games that has become central to contemporary economic theory. Haverford's Area of Concentration in Mathematical Economics enables students in each of the disciplines not only to gain proficiency in the other, but also to understand the ways in which they are related and complementary.

Mathematics Education (for majors interested in teaching mathematics)
The Bryn Mawr-Haverford Education Program invites students to study the discipline of education; explore the interdisciplinary field of educational studies; begin the path of teacher preparation for traditional classrooms; and participate in teaching experiences in a range of classroom and extra-classroom settings. Focused on teaching and learning as social, political, and cultural activities, the Education Program challenges students to explore the relationships among schooling, human development, and society as they gain knowledge and skills of educational theory and practice. Students who complete one of the Education Program options are prepared to become lifelong learners, educators, researchers, leaders and agents of change.

For the requirements for these concentrations, see those headings in this catalog or visit the departmental website.

AFFILIATED PROGRAMS

Many of our graduates have pursued successful and interesting careers in various engineering disciplines. Our 4+1 program with the University of Pennsylvania, 3/2 engineering program with CalTech, and the Master's degree course exchange agreements with Swarthmore and the University of Pennsylvania offer robust—and unique—opportunities. For more information on these options, visit the Engineering website (*haverford.edu/engineering/*).

FACULTY

Lynne Butler
Professor

Charles Cunningham
Visiting Assistant Professor

Curtis Greene *(on leave 2017-2018)*
J. McLain King Professor of Mathematics

Heidi Goodson
Visiting Assistant Professor

David Lippel
Visiting Assistant Professor and Laboratory Instructor

Robert Manning
William H. and Johanna A. Harris Professor of Computational Science

Elizabeth Townsend Milicevic
Assistant Professor

Weiwen Miao
Chair and Professor

Joshua Sabloff
Professor

Eric Stachura
Visiting Assistant Professor

Jeff Tecosky-Feldman *(on leave Spring 2018)*
Senior Lecturer

COURSES

MATH H103 INTRODUCTION TO PROBABILITY AND STATISTICS

Weiwen Miao
Natural Science (NA), Quantitative (QU)
Basic concepts and methods of elementary probability and quantitative reasoning, with practical applications. Topics include: sample average and standard deviation, normal curves, regression, expected value and standard error, confidence intervals and hypothesis tests. Crosslisted: Mathematics, Statistics; Prerequisite(s): Not open to students who have (a) placed into 121 or higher, (b) taken 118 or higher, (c) taken any other introductory statistics class at Haverford or Bryn Mawr, (d) received a score of 4 or 5 on the AP Statistics exam. (Offered Fall 2017)

MATH H105 APPLIED MODELING WITH CALCULUS

Heidi Goodson
Natural Science (NA), Quantitative (QU)
An introduction to aspects of calculus useful in applied work in the natural and social sciences, with a strong emphasis on developing mathematical modeling skills. Topics include differential and integral calculus of functions of one variable, multivariable optimization, and modeling with differential equations. Applications to biology, economics, and physics. This course is taught at the level of a beginning calculus course, and no prior calculus experience is assumed. Prerequisite(s): Not open to students placing into MATH 118 or higher or with previous calculus credit, except with instructor consent. (Offered Spring 2018)

MATH H118 CALCULUS: DYNAMICS AND INTEGRATION

Jeff Tecosky-Feldman
Natural Science (NA), Quantitative (QU)
A study of the evolution of systems defined by difference and differential equations. Methods of analysis come from calculus: the limit, the derivative, and the integral from numerical, graphical, and symbolic perspectives. Enrollment in one lab hour is required. Not open to students placing into Math 121 or higher, except with instructor permission. Prerequisite(s): MATH 105 or placement. Not open to students with credit for MATH B102 (Calculus II) or equivalent, except with instructor consent. (Offered Fall 2017)

MATH H121 MULTIVARIABLE CALCULUS

Eric Stachura, Elizabeth Townsend Milicevic
Natural Science (NA), Quantitative (QU)
An introduction to functions of several variables, vector geometry, partial derivatives, optimization, Taylor's Theorem, multiple integrals, line integrals, and Green's and Stokes' Theorems. Enrollment in one lab hour is required. Prerequisite(s): MATH 118 or equivalent placement, or instructor consent. Not open to students who have previously taken multivariable calculus at the college level, either at Haverford or elsewhere, except with instructor consent. (Offered Fall 2017 and Spring 2018)

MATH H199 FIRST-YEAR SEMINAR: MATHEMATICS BEYOND CALCULUS

Joshua Sabloff
Natural Science (NA), Quantitative (QU)
Half-credit course designed to introduce and convey the flavor of mathematics beyond the introductory core sequence in calculus and linear algebra. A selection of topics will be covered, varying from year to year. Prerequisite(s): MATH 215 is a pre- or co-requisite, or instructor consent. (Offered Spring 2018)

MATH H203 STATISTICAL METHODS AND THEIR APPLICATIONS

Lynne Butler, Weiwen Miao
Natural Science (NA), Quantitative (QU)
An introduction to statistical methods used to analyze data in the natural and social sciences. It covers descriptive statistics, the binomial and normal distributions, expected value and variance, confidence intervals and hypothesis testing, comparison of two samples, regression, and analysis of variance. A required computer lab, using R, is taught alongside this course. Crosslisted: Mathematics, Statistics; Prerequisite(s): MATH 118 or higher, placement into MATH 121 or higher, or permission of instructor. Students who have taken another introductory statistics course at Haverford or Bryn Mawr may only enroll in STAT 203 with permission of instructor. (Offered Fall 2017 and Spring 2018)

MATH H204 DIFFERENTIAL EQUATIONS
Eric Stachura
Natural Science (NA), Quantitative (QU)
An introduction to the theory of ordinary differential equations (ODEs) including algebraic techniques for solving a single ODE or a linear system of ODEs, numerical techniques for generating approximate solutions, geometric techniques for displaying solutions to understand their behavior, and some key theorems (such as existence and uniqueness of solutions). The course includes a focus on how ideas from linear algebra and multivariable calculus can be used to classify fixed points of nonlinear systems of ODEs. Prerequisite(s): MATH 215 and MATH 121 (or 216), or instructor consent. (Offered Spring 2018)

MATH H210 LINEAR OPTIMIZATION AND GAME THEORY
Curtis Greene
Natural Science (NA)
Covers in depth the mathematics of optimization problems with a finite number of variables subject to constraints. Applications of linear programming to the theory of matrix games and network flows are covered, as well as an introduction to nonlinear programming. Emphasis is on the structure of optimal solutions, algorithms to find them, and the underlying theory that explains both. This course is designed for students interested in computer science, economics, or mathematics. Prerequisite(s): MATH 215 or equivalent, or instructor consent. (Typically offered every other year)

MATH H215 LINEAR ALGEBRA
Elizabeth Townsend Milicevic
Natural Science (NA), Quantitative (QU)
An abstract introduction to linear algebra, focusing on proof techniques. Topics covered include: vector spaces, linear transformations and matrices, determinants, eigenvalue problems, quadratic forms, and the spectral theorem. One extra hour of weekly discussions. Prerequisite(s): MATH 121 or equivalent placement, or 118 with instructor consent (Offered Fall 2017 and Spring 2018)

MATH H216 MULTIVARIABLE CALC USING LINEAR ALGEBRA
Lynne Butler
Natural Science (NA), Quantitative (QU)
Calculus in n-dimensional Euclidean space: continuous and differentiable functions, extreme value problems, multiple integration, line and surface integrals, parametrized surfaces, Green's, Gauss' and Stokes' Theorems. Tools from linear algebra are used to formulate general statements of definitions, theorems and proofs. Prerequisite(s): Not open to students who have previously taken multivariable calculus at the college level, either at Haverford or elsewhere, except with instructor permission. Requires a strong background in single-variable calculus and a course in linear algebra, or instructor consent. (Offered Spring 2018)

MATH H218 PROBABILITY
Lynne Butler
Natural Science (NA), Quantitative (QU)
An introduction to probability theory. Topics include: sample spaces, combinatorics, conditional probability, independence, discrete and continuous random variables, functions of random variables, expected value and variance, the moment generating function, and some basic limit theorems. Prerequisite(s): MATH 216 or 121 or instructor consent. (Offered Fall 2017)

MATH H222 SCIENTIFIC COMPUTING: CONTINUOUS SYSTEMS
Robert Manning
Natural Science (NA), Quantitative (QU)
A survey of major algorithms in modern scientific computing, with a focus on continuous problems. Topics include numerical differentiation and integration, numerical linear algebra, root-finding, optimization, Monte Carlo methods, and discretization of differential equations. Basic ideas of error analysis are presented. A regular computer lab introduces students to the software package Matlab, in which the algorithms are implemented and applied to various problems in the natural and social sciences. Crosslisted: Mathematics, Computer Science; Prerequisite(s): MATH 215 or instructor consent. (Offered Fall 2017)

MATH H231 DISCRETE MATHEMATICS
Steven Lindell
Natural Science (NA)
An introduction to discrete mathematics with strong applications to computer science. Topics include set theory, functions and relations, propositional logic, proof techniques, difference equations, graphs, and trees. Crosslisted: Computer Science, Mathematics; Co-requisite(s): CMSC 105, 107, or 110, or instructor consent. (Offered Fall 2017)

MATH H286 APPLIED MULTIVARIATE STATISTICAL ANALYSIS
Weiwen Miao
Natural Science (NA), Quantitative (QU)
An introduction to multivariate statistical analysis. The course includes methods for choosing, fitting, and evaluating multiple regression models and analysis of variance models. A required computer lab, using R, is taught alongside this course. Crosslisted: Mathematics, Statistics; Prerequisite(s): MATH 215 and one of the following: ECON 204, MATH 203, PSYC 200, SOCL 215; or instructor consent. (Typically offered every other year)

MATH H317 ANALYSIS I
Joshua Sabloff
Natural Science (NA)
A rigorous development of topics in calculus, including the axioms of the real number line, cardinality, convergence of sequences, point-set topology (open/closed sets, compactness, connectedness), continuity, differentiability, and the Riemann integral. The course also has a major focus on the writing of clear and correct mathematical proofs. Prerequisite(s): MATH 215 and either 121 or 216, or instructor consent. (Offered Fall 2017)

MATH H318 ANALYSIS II
Robert Manning
Natural Science (NA)
A continuation of MATH 317, focusing on measure theory, the Lebesgue integral, function spaces, and sequences and series of functions with applications (e.g., Fourier series, existence and uniqueness of solutions to differential equations). Prerequisite(s): MATH 317 or instructor consent. (Offered Spring 2018)

MATH H328 MATHEMATICAL STATISTICS
Weiwen Miao
Natural Science (NA)
An introduction to mathematical theory of statistics. Topics include: Estimation, Hypothesis Testing, one-sample inference, two-sample inference, and regression. Additional topics may include: goodness-of-fit tests and analysis of variance. Crosslisted: Mathematics, Statistics; Prerequisite(s): MATH 218 or instructor consent. (Offered Spring 2018)

MATH H333 ALGEBRA I
Heidi Goodson
Natural Science (NA)
A rigorous treatment of fundamental algebraic structures. Topics include: introduction to groups, modular arithmetic, polynomials, rings, fields, Galois theory, vector spaces, and modules. Prerequisite(s): MATH 215 and either 121 or 216, or instructor consent. (Offered Fall 2017)

MATH H334 ALGEBRA II
Heidi Goodson
Natural Science (NA)
A continuation of Math 333. Topics include: group actions, Sylow's theorems, representation theory of finite groups, finite abelian groups, Galois theory, advanced linear algebra, and modules. Prerequisite(s): MATH 333 or instructor consent. (Offered Spring 2018)

MATH H335 TOPOLOGY
Staff
Natural Science (NA)
Generalizes topological concepts from Euclidean spaces to arbitrary topological spaces, and introduces elements of algebraic topology. Concepts covered include continuity, connectedness, and compactness. The course culminates in an exploration of the fundamental group and covering spaces. Prerequisite(s): MATH 317 and 333 (333 can be a corequisite), or instructor consent. (Offered Fall 2017)

MATH H337 DIFFERENTIAL GEOMETRY
Joshua Sabloff
Natural Science (NA)
A study of the differential geometry of curves and surfaces. Concepts covered include both the local theory (including metrics, curvature, and geodesics) and the global theory, including the Gauss-Bonnet theorem. Prerequisite(s): MATH 317 or MATH 216 with special permission, or instructor consent. (Offered Spring 2018)

MATH H340 ANALYSIS OF ALGORITHMS
Sorelle Friedler
Natural Science (NA)
Qualitative and quantitative analysis of algorithms and their corresponding data structures from a precise mathematical point of view. Performance bounds, asymptotic and probabilistic analysis, worst case and average case behavior. Correctness and complexity. Particular classes of algorithms such as sorting searching will be studied in detail. Crosslisted: Mathematics, Computer Science; Prerequisite(s):

CMSC 106 or 107 or B206, and 231, or instructor consent. (Typically offered every fall)

MATH H345 THEORY OF COMPUTATION
Steven Lindell
Natural Science (NA)
Introduction to the mathematical foundations of computer science: finite state automata, formal languages and grammars, Turing machines, computability, unsolvability, and computational complexity. Class will have a required discussions session on Fridays from 10:00-11:30. Attendance required. Prerequisite(s): (CMSC 106 or CMSC 107) and CMSC 231, and junior or senior standing, or instructor consent. (Offered Spring 2018)

MATH H360 MATHEMATICAL ECONOMICS
Giri Parameswaran
Social Science (SO), Quantitative (QU)
A study of advanced mathematical tools used in economic analysis. Topics include eigenvalues and quadratic forms, differential equations, convex programming and dynamic programming. Applications to consumer theory, generalized linear regression, stability of equilibrium, and models of growth and search. Fulfills Mathematic Economics (MTEC) concentration. Crosslisted: Economics, Mathematics; Prerequisite(s): MATH 215; either MATH 121 or 216; ECON 203 or 204 or MATH 203 or SOCL 215 or PSYC 200 or Bryn Mawr's ECON B253 recommended, or instructor consent. (Offered Fall 2017)

MATH H392 ADVANCED TOPICS IN ANALYSIS AND GEOMETRY: COMPLEX ANALYSIS
Heidi Goodson
Natural Science (NA)
An introduction to differentiation and integration of functions of a complex variable. Topics include the complex plane and elementary functions, complex differential calculus, integration and Cauchy's integral formula. Applications to physical science and number theory may be discussed. Prerequisite(s): MATH 317 or instructor consent. (Typically offered every other year)

MATH H394 ADVANCED TOPICS IN THEORETICAL COMPUTER SCIENCE
David Lippel
Natural Science (NA)
Crosslisted: Computer Science, Mathematics; Prerequisite(s): MATH 317 or MATH 333 or instructor consent. (Offered Spring 2018)

MATH H396 ADVANCED TOPICS IN PROBABILITY AND STATISTICS
Curtis Greene
Natural Science (NA), Quantitative (QU)
Various topics in statistics will be covered. Crosslisted: Mathematics, Statistics; Prerequisite(s): MATH 218 and one of the following: MATH 203, ECON 203/204, PSYC 200, SOCL 215; or instructor consent. (Typically offered every other year)

MATH H397 ADVANCED TOPICS IN APPLIED MATHEMATICS
Eric Stachura
Natural Science (NA)
An advanced course in some area of applied math, with topics varying according to instructor. Recent versions have covered partial differential equations (2016, 2012, 2011) and dynamical systems/chaos (2014, 2009). The course typically involves a mix of theory (often an extension of ideas seen in real analysis) and computation. Prerequisite(s): MATH 317 or instructor consent. (Typically offered every other year)

MATH H399 SENIOR SEMINAR
Weiwen Miao
Natural Science (NA)
Seminar for students writing senior papers, dealing with the oral and written exposition of advanced material. (Offered Fall 2017)

MATH H400 SENIOR RESEARCH
Staff
Natural Science (NA)
Work on senior thesis with advisor. (Offered Fall 2017)