MATHEMATICS AND STATISTICS

Department Overview

Mathematics and statistics, as academic disciplines, are fascinating to study in their own right but also have very wide-ranging applications throughout the modern world. Our faculty are all skilled and dedicated teachers as well as active scholars; we strive to make each course we offer engaging and challenging. Our graduates go on to a great variety of careers and graduate programs in such areas as theoretical mathematics, applied mathematics, biostatistics and statistics, actuarial science, teaching at various levels, and many more.

Advice for Students Beginning the Study of College Mathematics

Students who plan to study mathematics at Skidmore should take the online Calculus Placement Exam prior to the beginning of classes (www.skidmore.edu/mcs/calcplacement.php (http://www.skidmore.edu/mcs/calcplacement.php)). Based on the results of this exam, the department will recommend in which courses of the sequence the student should begin:

Code	Title	Hours
MA 108 & MA 109	Calculus with Algebra I and Calculus with Algebra II (a two-semester version of Calculus I for students who need additional pre-calculus preparation)	6
MA 111	Calculus I	4
MA 113	Calculus II	4
MA 200	Linear Algebra	4
MA 211	Calculus III	3

Credit for Advanced Placement

Students receiving a score of 4 or 5 on the Math AB AP exam will receive credit for having taken MA 111 Calculus I. Students receiving a score of 4 or 5 on the Math BC AP exam will receive credit for having taken MA 113 Calculus II and will have the requirement for MA 114 Sequences and Series waived . Students receiving a score of 4 or 5 on the Statistics AP exam will receive credit for having taken MS 104 Introduction to Statistics. (Please note: For students who enter Fall 2024 and beyond, Statistics AP will not be equivalent to MS 104 and students will only receive general elective credit.)

Chair of the Department of Mathematics and Statistics: Julie Douglas

Associate Chair: Lucy Oremland

Calculus Placement Coordinator: David Vella

S3M Program Director: Rebecca Trousil

Professors: Julie Douglas, R. Daniel Hurwitz, Rachel Roe-Dale, David Vella

Associate Professor: Lucy Oremland

Assistant Professors: Patrick Daniels, Kirsten Hogenson, Vojtech Kejzlar, Greg Malen

Visiting Assistant Professors: Cristobal Lemus-Vidales

Senior Teaching Professors: Csilla Szabo, Rebecca Trousil

Lecturers: Megan DiMaio, [1]Bert Rawert, [1]Rachel Seligman, [1]Carrie Yecies

[1] Part-time

Mathematics B.A.

For Students Who Entered Skidmore in Fall 2022 and Beyond

Students majoring in mathematics fulfill the departmental requirements by completing 11 courses. These courses must be in mathematics or a designated course in statistics, computer science, or economics at the 200 level or above, to include:

Code	Title	Hours
Students who plan to major in mathematics should complete the pre-requisites below:		
Pre-requisite courses [1-3]		
MA 108 & MA 109	Calculus with Algebra I and Calculus with Algebra II	4-6
or MA 111	Calculus I	
MA 113	Calculus II	4
MA 114	Sequences and Series	2
Required Courses [1-4]		
MA 200	Linear Algebra	4
MS 204	Statistical Methods [5]	4
MA 211	Calculus III	3
MA 213	Calculus IV	3
MA 215	Introduction to Mathematical Reasoning and Proof [6]	4
MA 303	Introduction to Analysis	4
MA 319	Abstract Algebra I	4
MA 376	Senior Seminar in Mathematics	3
Select two additional courses, at least one of which is at the 300 level [7-8]		6-8
CS 106	Introduction to Computer Science I	4
or CS 209	Data Structures and Mathematical Foundations	
or CS 226	Software Design	
Total Hours		**49-53**

[1] All students should complete the online Calculus Placement Exam to determine which calculus course is best suited for them. Students who receive a score of 4 or 5 on the Math AB AP exam will receive credit for having taken MA 111 Calculus I, while students who received a score of 4 or 5 on the Math BC AP exam will receive credit for having taken MA 113 Calculus II and will have the requirement for MA 114 Sequence and Series waived.

[2] MA 114 Sequence and Series may be taken concurrently with MA 113 Calculus II and is a pre-requisite for MA 303 Introduction to Analysis, a required course for the math major (see below).

[3] For students who entered Skidmore in Fall 2022 and beyond, MA 114 is a pre-requisite for the mathematics major.

[4] No more than 4 credit hours of S/U can be used toward the major. (****For students who entered Skidmore in Fall 2021 and beyond:** The following courses are excluded: MA 215 Introduction to Mathematical

Reasoning and Proof, MA 303 Introduction to Analysis, MA 319 Abstract Algebra I, MA 376 Senior Seminar in Mathematics, MA 381 Senior Thesis, MA 382 Senior Thesis.)

[5] Students who have taken MS 104 (https://catalog.skidmore.edu/search/?P=MS%20104) Introduction to Statistics are not eligible to take MS 204 (https://catalog.skidmore.edu/search/?P=MS%20204) Statistical Methods (and vice versa). If a student has already taken MS 104 prior to declaring the math major, then the student must take another 3- or 4-credit 200- or 300-level course designated MA or MS.

[6] In MA 215 Introduction to Mathematical Reasoning and Proof, students will acquire writing skills that are necessary to work on advanced material in mathematics and will fulfill the writing requirement in the major.

[7] Additionally, one of the following courses can count toward the mathematics major. MS 204 (https://catalog.skidmore.edu/search/?P=MS%20204) Statistical Methods (for students who entered Skidmore before Fall 2021), MS 240 (https://catalog.skidmore.edu/search/?P=MS%20240) Applied Regression Analysis, MS 251 Topics in Statistics: Bayesian Statistical Modeling or Multivariate Data Analysis, CS 316 Foundations of Machine Learning, EC 361 Advanced Topics In Economics Game Theory, or Mathematical Economics.

[8] Under exceptional circumstances, and only with the consent of the department, MA 351 Selected Topics in Mathematics, MA 371 Independent Study Math, MA 381 Senior Thesis, MA 382 Senior Thesis, or MS 351 Topics in Statistics may be counted as the additional 300-level course.

Students interested in pursuing graduate work in (theoretical) mathematics should include as many of the following courses as possible in their programs:

Code	Title	Hours
MA 302	Graph Theory	3
MA 313	Introduction to Topology	3
MA 320	Abstract Algebra II	3
MA 324	Complex Analysis	3

Students interested in applied mathematics should include as many of the following courses as possible in their programs:

Code	Title	Hours
MA 270	Differential Equations	4
MA 316	Numerical Algorithms	3
MA 324	Complex Analysis	3
MA 331	Dynamical Systems	3

Students interested in mathematics education should include as many of the following courses as possible in their programs:

Code	Title	Hours
MS 204	Statistical Methods	4
MA 214	Theory of Numbers	3
MA 309	Elements of Modern Geometry	3
MA 310	History of Mathematics	3

For Students Who Entered Skidmore in Fall 2019 - Fall 2021

Students majoring in mathematics fulfill the departmental requirements by completing 10 courses. These courses must be in mathematics or a designated course in statistics, computer science, or economics at the 200 level or above, to include:

Code	Title	Hours
Required Courses [1]		
MA 200	Linear Algebra	4
MA 211	Calculus III	3
MA 213	Calculus IV	3
MA 215	Introduction to Mathematical Reasoning and Proof [2]	4
MA 303	Introduction to Analysis	4
MA 319	Abstract Algebra I	4
MA 376	Senior Seminar in Mathematics	3
Select two additional courses, at least one of which is at the 300 level [3,4]		6-8
CS 106	Introduction to Computer Science I	4
or CS 206	Introduction to Computer Science II	
Total Hours		**35-37**

[1] No more than 4 credit hours of S/U can be used toward the major. (****For students who entered Skidmore in Fall 2021 and beyond:** The following courses are excluded: MA 215 Introduction to Mathematical Reasoning and Proof, MA 303 Introduction to Analysis, MA 319 Abstract Algebra I, MA 376 Senior Seminar in Mathematics, MA 381 Senior Thesis, MA 382 Senior Thesis.)

[2] In MA 215 Introduction to Mathematical Reasoning and Proof, students will acquire writing skills that are necessary to work on advanced material in mathematics and will fulfill the writing requirement in the major.

[3] Under exceptional circumstances, and only with the consent of the department, MA 351 Selected Topics in Mathematics, MA 371 Independent Study Math, MA 381 Senior Thesis, MA 382 Senior Thesis, or MS 351 Topics in Statistics may be counted as the additional 300-level course.

[4] Additionally, one of the following courses can count toward the mathematics major. MS 204 (https://catalog.skidmore.edu/search/?P=MS%20204) Statistical Methods (for students who entered Skidmore before Fall 2021), MS 240 (https://catalog.skidmore.edu/search/?P=MS%20240) Applied Regression Analysis, MS 251C Bayesian Statistical Modeling, MS 251C Multivariate Data Analysis, CS 316 Foundations of Machine Learning, EC 361 Advanced Topics In Economics Game Theory, or Mathematical Economics.

Students interested in pursuing graduate work in (theoretical) mathematics should include as many of the following courses as possible in their programs:

Code	Title	Hours
MA 302	Graph Theory	3
MA 313	Introduction to Topology	3
MA 320	Abstract Algebra II	3
MA 324	Complex Analysis	3

Students interested in applied mathematics should include as many of the following courses as possible in their programs:

Code	Title	Hours
MA 270	Differential Equations	4
MA 316	Numerical Algorithms	3
MA 324	Complex Analysis	3
MA 331	Dynamical Systems	3

Students interested in mathematics education should include as many of the following courses as possible in their programs:

Code	Title	Hours
MS 204	Statistical Methods	4
MA 214	Theory of Numbers	3
MA 309	Elements of Modern Geometry	3
MA 310	History of Mathematics	3

Mathematics Minor

Students minoring in mathematics fulfill the departmental requirements by completing:

Code	Title	Hours
Required Courses [1,2]		
MA 113	Calculus II	4
MA 200	Linear Algebra (or the equivalent)	4
MA 215	Introduction to Mathematical Reasoning and Proof	4
MA 303	Introduction to Analysis	4
or MA 319	Abstract Algebra I	
Select two more 3- or 4-credit courses in mathematics at the 200 or 300 level [3]		6-8
Total Hours		**22-24**

[1] No more than 8 credit hours of S/U may be used toward the minor.

[2] **For students entering Skidmore in Fall 2021 and beyond:** No more than 4 credit hours of S/U may be used toward the minor. The following courses must be taken for a letter grade: MA 215 Introduction to Mathematical Reasoning and Proof, MA 303 Introduction to Analysis, MA 319 Abstract Algebra I, MA 376 Senior Seminar in Mathematics, MA 381 Senior Thesis, MA 382 Senior Thesis.

[3] Additionally, one of the following courses can count toward the mathematics minor: MS 204 (https://catalog.skidmore.edu/search/?P=MS%20204) Statistical Methods, MS 240 (https://catalog.skidmore.edu/search/?P=MS%20240) Applied Regression Analysis, MS 251 Topics in Statistics: Bayesian Statistical Modeling, or Multivariate Data Analysis, CS 316 Foundations of Machine Learning, EC 361 Advanced Topics In Economics Game Theory, or Mathematical Economics.

Statistics Minor

The minor in statistics requires completing five 3- or 4-credit courses. These must include two core courses and three elective courses from the list below. Three of the five courses must be designated MA or MS.

Code	Title	Hours
Required Courses [1]		
Introductory Statistics Core Course		
Select one of the following:		4
MS 104	Introduction to Statistics [2]	
MS 204	Statistical Methods (strongly recommended) [2]	
BI 235	Biostatistics	
EC 237	Statistical Methods	
PS 202	Statistics and Research Methods I	
Statistics Core Course		
MS 240	Applied Regression Analysis	4
Elective Courses [3,4,5]		
Select three of the following:		9-12
Courses in Statistics and Mathematics:		
MS 210	Data Visualization	
MS 251C	(Bayesian Statistical Modeling)	
MS 251C	(Multivariate Data Analysis)	
MA 351C & MA 351D	and (Introduction to Probability)	
Approved Outside Elective Courses:		
CS 225	Applied Data Science	
CS 316	Foundations of Machine Learning	
EC 339	Applied Econometrics	
EC 361	Advanced Topics In Economics	
GE 235	Data Analysis, Modeling, and Scientific Programming: Earth and Environmental Sciences	
ID 210	Introduction to GIS	
ID 351	Advanced Topics in Interdisciplinary Study (Advanced GIS and Modeling) [6]	
PL 302	Experiments in Political Science	
PS 303	Research Methods 2: Intermediate Statistics	
SO 227	Social Research Methods	
Total Hours		**17-20**

[1] No more than 4 credit hours of S/U may be used toward the minor.

[2] Students who have taken MS 104 Introduction to Statistics are not eligible to take MS 204 Statistical Methods (and vice versa).

[3] The senior seminar (MA 376 Senior Seminar in Mathematics) may count as an elective toward the minor if the topic is statistical and with the approval of the department.

[4] With the consent of the department, an independent study or honors project that involves a substantial statistical component may count toward the minor. The course must be designated MS 371 Independent Study, MA 381 Senior Thesis, or MA 382 Senior Thesis.

[5] Other elective courses from outside the department that include a substantial statistical component may count toward the minor with the consent of the department.

Honors

Students wishing to qualify for departmental honors in the mathematics major must:

Portfolio Option

1. Complete all departmental requirements for the mathematics major and have a GPA of 3.75 or higher for all course work (MA, MS) taken in the department;

2. have a GPA of 3.0 for all course work taken at Skidmore;

3. file with the Department a declaration of intention to qualify for honors by the end of the official add-drop period during the semester of graduation; and

4. Identify a faculty member to serve as the portfolio advisor (the portfolio advisor can but does not have to be the student's major advisor); and

5. submit a portfolio which demonstrates the student's commitment to the field of mathematical sciences and contributions to the Department. More details on the format of the portfolio can be found in the "Guidelines for Students Submitting a Portfolio."

6. Portfolios will be read by the review committee to see if the work is of the exceptional quality that merits honors. The review committee will submit its recommendation to the Department for final adjudication.

Or Thesis Option

1. Complete all departmental requirements for the mathematics major and have a GPA of 3.50 or higher for all course work (MA, MS) taken in the department;

2. have a GPA of 3.0 for all course work taken at Skidmore;

3. file with the Department a declaration of intention to qualify for honors by the end of the official add-drop period during the semester of graduation; and

4. submit an honors thesis to be read by a review committee and give an oral presentation of the thesis to the department. More details on the format of the thesis can be found in the "Guidelines for Students Writing a Thesis."

5. The final thesis must be submitted no later than 11 days prior to the last day of the semester of graduation; a draft thesis must be submitted to the thesis advisor at least one week prior to the final thesis due date.

6. The review committee will evaluate the thesis to determine if it is of the exceptional quality that merits honors; the committee's recommendation will be submitted to the department for final adjudication.

Pi Mu Epsilon, New York Alpha Theta Chapter

Incorporated in 1914, Pi Mu Epsilon is a national honorary society whose purpose is the promotion of scholarly activity in mathematics. Undergraduate students are qualified for membership if they meet one of the following criteria:

1. upperclassmen who have completed at least two years of college mathematics, including calculus, with at least a B average and who are in the top third of their class in general college work;

2. sophomores, majoring in or intending to major in mathematics, who have completed at least three semesters of college mathematics, including one year of calculus, with a straight-A record and who are in the top quarter of their class in general college work;

3. senior mathematics majors may also qualify with a 3.0 or better overall GOA and a 3.5 or better GPA for all MA and MS courses at the 200 and 300 levels.

Course Listing

All MA and MC courses (except MA 100 Quantitative Reasoning) have the satisfaction of QR1 as a prerequisite.

MA 100 - Quantitative Reasoning
Credits: 3
A practical study of the skills and tools needed to work with quantitative information from the real world. Students will learn and explore mathematical concepts such as arithmetic, fractions, decimals, percentages, descriptive statistics and basic probability, estimation, unit analysis, absolute and relative change, and linear and exponential growth. Students will also represent and interpret numerical data in tabular and graphical forms. Material will be applied to a wide variety of fields.
Note(s): This course is primarily intended to fulfill the first part of the Quantitative Reasoning requirement, QR1.

MA 102 - Mathematical Models in the Social and Management Sciences
Credits: 3
In many areas of the social and management sciences, mathematics can be used to make predictions, help allocate scarce resources, maximize profits, make policy decisions, and so on. This use of mathematics is called mathematical modeling. In this course we investigate a variety of scenarios which can arise in the "real world" where math modeling can come into play, and we learn about some of the most important techniques of math modeling such as linear programming, probability theory, statistical techniques, integer programming, and Markov chains.
Note(s): Course offered periodically, depending on faculty availability. Fulfills QR2 requirement.

MA 103 - Assume a Spherical Cow: A First Course in Math Modeling
Credits: 4
Provides students with an opportunity to study interdisciplinary problems through a quantitative lens. During the course, students will build models, analyze and interpret results using traditional mathematics and computer-based simulations, and present their findings in both written and oral presentations. Students will explore problems from many disciplines including ecology, biology, finance, and epidemiology. Modeling techniques studied in this course include discrete dynamical systems and stochastic models.
Prerequisites: FQR course or placement at AQR.
Note(s): Fulfills AQR requirement.

MA 107 - Concepts of Mathematics
Credits: 3
An introductory course for liberal arts and education majors or anyone seeking a general, nontechnical overview of mathematics. Topics covered include set theory, review of number systems, geometry concepts, basic concerns of probability and statistics, and introductory number theory.
Note(s): Offered periodically depending on faculty availability. Fulfills QR2 requirement.

MA 108 - Calculus with Algebra I
Credits: 3
An introduction to derivatives, integrals, and their applications. Primarily for students who are not adequately prepared for MA 111, this course (together with MA 109) covers the same material as MA 111 but integrates the material requisite to calculus with the calculus itself. Note that MA 108 alone cannot be used as a substitute for MA 111. Successful completion of MA 108 and MA 109 is equivalent to completion of MA 111.
Prerequisites: QR1 or MA 100 or placement at the FQR level or placement at the AQR level
Note(s): Offered fall semester.

MA 109 - Calculus with Algebra II
Credits: 3
A continuation of MA 108. A study of exponential, logarithmic, and trigonometric functions and their applications in differential and integral calculus. Successful completion of MA 108 and MA 109 is equivalent to completion of MA 111.
Prerequisites: MA 108.
Note(s): Offered spring semester. Fulfills QR2 requirement; fulfills Fundamental QR requirement.

MA 110 - Mathematics Toolkit
Credits: 3
A detailed study of the mathematical tools necessary for success in calculus and statistics courses. Students will build their quantitative reasoning skills, with a particular focus on understanding functions and covarying quantities. These skills include creating, refining, and algebraically manipulating models involving polynomials, rational functions, exponentials, logarithms, and trigonometric functions. Students will relate these models to real-life applications and analyze them from symbolic, graphical, and numerical perspectives.
Prerequisites: MA 100 or placement into an FQR or AQR course.
Note(s): Fulfills Fundamental QR requirement.

MA 111 - Calculus I
Credits: 4
Derivatives, integrals and their applications. Techniques of differentiation. Integration and differentiation of exponential, logarithmic and trigonometric functions.
Prerequisites: High school preparation including trigonometry. Requires AQR placement.
Note(s): Fulfills QR2 requirement.

MA 113 - Calculus II
Credits: 4
An exploration of integral calculus. Topics include techniques of integration, applications of integration, and improper integrals.
Prerequisites: Calculus placement exam, or MA 111, or both MA 108 and MA 109. Requires AQR placement.
Note(s): Fulfills QR2 requirement.

MA 113H - Honors:Calculus II
Credits: 4
An exploration of integral calculus. Topics include techniques of integration, applications of integration, and improper integrals.
Prerequisites: Calculus placement exam, or MA 111, or both MA 108 and MA 109. Requires AQR placement. (Fulfills QR2 requirement).

MA 114 - Sequences and Series
Credits: 2
An exploration of infinite sequences and series. Topics include geometric series, convergence tests, Taylor series, and power series.
Prerequisites: MA 113 and/or MA 113H taken either before or concurrently.

MA 116 - Math in the Museum
Credits: 2
An examination of how mathematical ideas are embodied in the visual arts, architecture, and design, and how the arts have helped shaped advances in math and computer science. From ancient Greek art to the Renaissance, and from Islamic patterns to contemporary computer-generated art, math has an important place in the world of art, architecture, and design both within museum spaces and all around us. Students will explore these relationships in the context of mathematical concepts such as geometry, proportion, basic statistics, measurements, and common functions by studying original works of art and actively engaging with these mathematical concepts through hands on exercises in Skidmore's Tang Teaching Museum.
Prerequisites: QR1 or MA 100 or placement at the FQR level or placement at the AQR level.
Note(s): Letter grade only. Fulfills Fundamental QR requirement.

MA 125 - Problem Solving in Mathematics
Credits: 1
Introductory level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.
Prerequisites: AQR placement.
Note(s): During fall semesters, students will have an opportunity to compete in the annual William Lowell Putnam Mathematical Competition. May be repeated for credit. Must be taken S/U.

MA 125H - Honors: Problem Solving In Mathematics (Fr)
Credits: 1
Introductory level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

MA 126H - Honors: Problem Solving
Credits: 1
Introductory level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

MA 200 - Linear Algebra
Credits: 4
Vector spaces, matrices and linear transformations, determinants, solution of linear equations.
Prerequisites: High school preparation including trigonometry. Requires AQR placement.
Note(s): Fulfills QR2 requirement.

MA 202 - Calculus III
Credits: 4
Multivariable calculus. Topics include vector functions, partial derivatives, multiple integrals, vector fields, and line integrals.
Prerequisites: MA 113 or calculus placement exam.

MA 204 - Probability and Statistics
Credits: 3
Elementary probability, discrete and continuous random variables, theory of expectation, analysis of distribution functions.
Prerequisites: MA 111, or both MA 108 and MA 109.
Note(s): Normally offered spring term of odd-numbered years. Fulfills QR2 requirement.

MA 211 - Calculus III
Credits: 3
An exploration of multivariable calculus. Topics include parametric equations, polar coordinates, conic sections, vector functions, partial derivatives, and gradients.
Prerequisites: MA 113 or calculus placement exam.

MA 213 - Calculus IV
Credits: 3
Multivariable calculus. Topics include vector functions, partial derivatives, multiple integrals, vector fields, line integrals, surface integrals, vector calculus, divergence and curl.
Prerequisites: MA 211 or MA 202 or permission of instructor.

MA 214 - Theory of Numbers
Credits: 3
Topics in classical and modern number theory including congruences, Diophantine equations, quadratic residues.
Prerequisites: MA 111, or both MA 108 and MA 109, or MA 200. Requires AQR placement.
Note(s): Normally offered spring semester of even-numbered years. Fulfills QR2 requirement.

MA 215 - Introduction to Mathematical Reasoning and Proof
Credits: 4
An introduction to mathematical proof and concepts of abstract mathematics, including elementary logic, methods of proof, set theory, functions and relations.
Prerequisites: CS 106 or MA 113 or permission of the department.
Note(s): Fulfills QR2 requirement.

MA 225 - Problem Solving In Mathematics
Credits: 1
Intermediate level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.
Prerequisites: AQR placement.
Note(s): During fall semesters, students will have an opportunity to compete in the annual William Lowell Putnam Mathematical Competition. May be repeated for credit. Must be taken S/U.

MA 225H - Honors: Problem Solving In Mathematics (So)
Credits: 1
Intermediate level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

MA 226H - Honors: Problem Solving
Credits: 1
Intermediate level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

MA 251 - Selected Topics in Mathematics
Credits: 1-4
Topics that complement the established lower level course offerings in mathematics will be selected. Emphasis will be on the nature of mathematical thought.
Prerequisites: QR1.
Note(s): May be repeated for credit. Offered on sufficient demand.

MA 270 - Differential Equations
Credits: 4
An introduction to the theory and applications of differential equations.
Prerequisites: MA 113 and MA 200.

MA 275H - Research Topics in Mathematics
Credits: 1
Exploration of a research topic in mathematics. The students, in collaboration with a faculty mentor, will participate in a research project in a particular area of mathematics which may be related to the faculty member's research program.
Prerequisites: Permission of instructor.

MA 302 - Graph Theory
Credits: 3
An introduction to the theory and applications of graphs. Topics may include graphs and digraphs, connectivity, trees, Euler and Hamiltonian cycles, and graph embeddings.
Prerequisites: MA 215.
Note(s): Normally offered fall semester of odd-numbered years.

MA 303 - Introduction to Analysis
Credits: 4
Rigorous treatment of foundational issues in analysis. Topics may include set theory, the real number system, sequences, series, limits and continuity, theory of differentiation and integration, and elementary notions of topology.
Prerequisites: MA 113, MA 114 and MA 215.
Note(s): Offered fall semester each year and spring semester of even-numbered years.

MA 305 - Introduction to Probability
Credits: 4
An introduction to the theory of probability and applications of probability in modeling real world phenomena. The goal of this course is to introduce students to the language, ideas, and tools of probability, the science of uncertainty. Probabilistic concepts, derivations, and problem solving are emphasized. Computational tools will also be used to explore and verify theoretical results. Topics include counting methods, random variables, discrete and continuous distributions, mathematical expectation, functions of random variables, joint distributions, and limit theorems.
Prerequisites: MA 113 and MA 215.

MA 309 - Elements of Modern Geometry
Credits: 3
Study of various topics in modern geometry, with emphasis on the axiomatic method.
Prerequisites: MA 113 and MA 215.
Note(s): Normally offered fall semester of even-numbered years. May be repeated for credit with a different topic.

MA 310 - History of Mathematics
Credits: 3
Study of the development of mathematical ideas.
Prerequisites: MA 113 and MA 215.
Note(s): Normally offered spring semester of odd-numbered years.

MA 311 - Differential Geometry
Credits: 3
An introduction to differential geometry in a classical setting: the study of n-surfaces, embedded in Euclidean space.
Prerequisites: MA 200, MA 202, and MA 215.
Note(s): MA 270 recommended. Offered on sufficient demand.

MA 313 - Introduction to Topology
Credits: 3
Selected topics in topology such as metric spaces, point set topology of Euclidean spaces, introduction to algebraic topology.
Prerequisites: MA 113 and MA 215.
Note(s): Normally offered spring semester of odd-numbered years.

MA 316 - Numerical Algorithms
Credits: 3
An introduction to using computation to obtain approximate solutions to mathematical problems. A variety of algorithms are studied, as are the limitations of using computational methods. Topics include algorithms for solving equations, systems, and differential equations; approximating functions and integrals; curve fitting; round-off errors, and convergence of algorithms.
Prerequisites: MA 111 (or both MA 108 and MA 109), CS 106, and MA 200.
Note(s): Normally offered fall semester of even-numbered years.

MA 319 - Abstract Algebra I
Credits: 4
Survey of algebraic structures; groups, rings, fields, vector spaces, and linear transformations.
Prerequisites: MA 200 and MA 215.
Note(s): Offered fall semester each year and spring semester of odd-numbered years.

MA 320 - Abstract Algebra II
Credits: 3
Selected topics in advanced algebra.
Prerequisites: MA 319.
Note(s): Normally offered spring semester of even-numbered years.

MA 323 - Real Analysis
Credits: 3
Selected topics in real analysis.
Prerequisites: MA 303.
Note(s): Offered on sufficient demand.

MA 324 - Complex Analysis
Credits: 3
Analytic functions, complex integration, complex sequences and series, and conformal mapping.
Prerequisites: MA 303.
Note(s): Normally offered spring semester of even-numbered years.

MA 325 - Problem Solving In Mathematics
Credits: 1
Advanced level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.
Prerequisites: AQR placement.
Note(s): During fall semesters, students will have an opportunity to compete in the annual William Lowell Putnam Mathematical Competition. May be repeated for credit. Must be taken S/U.

MA 325H - Honors: Problem Solving In Mathematics (Jr/Sr)
Credits: 1
Advanced level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

MA 326H - Honors: Problem Solving
Credits: 1
Advanced level. Students will work collaboratively on problems posed in various undergraduate mathematics journals and other sources. Solutions to journal problems will be submitted to the journal editors for acknowledgment and possible publication. Problems are taken from all areas of specialty within mathematics.

MA 331 - Dynamical Systems
Credits: 3
A study of dynamical systems and their application. Topics covered include first-order equations, bifurcation theory, linear systems, phase plane analysis, and chaos. Examples will be considered from problems in medicine and the natural and social science.
Prerequisites: MA 270.
Note(s): Normally offered fall semester of odd-numbered years.

MA 351 - Selected Topics in Mathematics
Credits: 1-4
Topics that complement the established upper level course offerings in mathematics will be selected. Emphasis will be on the nature of mathematical thought.
Prerequisites: MA 215.

MA 371 - Independent Study Math
Credits: 1-4
Special study in mathematics outside the regular department offerings.

MA 376 - Senior Seminar in Mathematics
Credits: 3
Research, discussion, and presentation of selected topics at an advanced level, to provide a capstone experience for the mathematics major; primarily intended for seniors. Senior Seminar in Mathematics - Research, discussion, and presentation of selected topics at an advanced level, to provide a capstone experience for the mathematics major; primarily intended for seniors.
Prerequisites: Senior status, MA 215, one 300-level course in Mathematics, in addition to any specific courses required by the instructor.
Note(s): Offered spring semester. In exceptional circumstances non-senior students may be permitted to enroll in the course with department approval. This course may be repeated for credit with permission of the department. Fulfills Senior Experience Coda requirement.

MA 381 - Senior Thesis
Credits: 3
Optional for mathematics majors. Recommended for those working toward professional careers or graduate study in mathematics, and required for those seeking to satisfy the criteria for departmental honors.
Prerequisites: Permission of department.
Note(s): Optional for mathematics majors. Recommended for those working toward professional careers or graduate study in mathematics, and required for those seeking to satisfy the criteria for departmental honors.

MA 382 - Senior Thesis
Credits: 3
Optional for mathematics majors. Recommended for those working toward professional careers or graduate study in mathematics, and required for those seeking to satisfy the criteria for departmental honors.
Prerequisites: Permission of department.

MA 399 - Internship in Mathematics
Credits: 1-4
Professional experience at an advanced level for juniors and seniors with substantial academic experience in mathematics. With faculty sponsorship and departmental approval, students may extend their educational experience in pure or applied mathematics. This course may not be used to satisfy the requirements of any major or minor in the department.
Prerequisites: MA 200, two additional courses in mathematics at the 200 level or above, and permission of department.
Note(s): Not for liberal arts credit.

MS 104 - Introduction to Statistics
Credits: 4
An introduction to fundamental concepts in statistical reasoning. Students will consider contexts, both historical and modern, in which statistical approaches arose and methodologies developed. Topics considered will include organization and analysis of data, the drawing of inferences from these data, and the careful presentation of these inferences. Examples will be drawn from a variety of disciplines.
Prerequisites: Placement at the AQR level or completion of an FQR course or QR1.
Note(s): Students who have received credit for SO 226 or EC 237 may not receive credit for MS 104. Fulfills QR2 requirement; fulfills Applied QR requirement.

MS 204 - Statistical Methods
Credits: 4
An introduction to statistical methods. Students will learn sampling strategies, exploratory data analysis, hypothesis testing, and randomization-based strategies, with examples from a variety of disciplines. This course is designed for majors in STEM fields and/or those with strong quantitative skills.
Prerequisites: Placement at the AQR level or completion of an FQR course or QR1.
Note(s): This course is not open to those who have taken MS 104. Fulfills QR2 requirement; fulfills Applied QR requirement. Three hours of lecture and two hours of lab per week.

MS 210 - Data Visualization
Credits: 3
An introduction to data visualization. Students will learn to use data visualization tools, to objectively critique and redesign graphics, and to produce and describe visualizations using the R/RStudio statistical software. A willingness to code is needed. (Fulfills QR2 requirement).

MS 240 - Applied Regression Analysis
Credits: 4
A continuation of introductory statistics, this course is intended for students in the physical, social, or behavioral sciences. Topics include multiple linear regression, indicator variables, model diagnostics, transformations and selection strategies, logistic and multiple logistic regression, and analysis of variance. Emphasis will be on applying tools to real data as well as the interpretation of results. The class will make extensive use of the R/RStudio statistical software, which is free to download and use.
Prerequisites: MS 104 or the equivalent.
Note(s): Fulfills QR2 requirement.

MS 251 - Topics in Statistics
Credits: 1-4
Topics that complement the established lower level course offerings in statistics will be selected. Emphasis will be on the nature of statistical thought.
Prerequisites: Will vary with course.

MS 275H - Research Topics in Statistics
Credits: 1
Exploration of a research topic in statistics. The students, in collaboration with a faculty mentor, will participate in a research project in a particular area of statistics which may be related to the faculty member's research program.

MS 351 - Topics in Statistics
Credits: 1-4
Topics that complement the established upper-level course offerings in statistics.
Prerequisites: MS 204 or equivalent. Additional prerequisites vary with topic and instructor.

MS 371 - Independent Study
Credits: 1-4
Special study in statistics outside the regular department offerings.