

MATHEMATICAL SCIENCES

Chair: Yung-Pin Chen

Administrative Coordinator: Anne Boal

The mathematical sciences—mathematics, statistics, and computer science—continue to play a central role in the evolution of civilization. With a focus on patterns and structure, and with methodologies based on computation and representation of information, the mathematical sciences foster coherence and understanding that enable technology and broaden insights about the world of natural science.

The goal of the department is to acquaint students with this role as it relates to developments within the mathematical sciences, as well as to applications to other disciplines. The department focuses on two distinct but complementary responsibilities: the mathematical sciences as an essential component of a liberal arts education and the mathematical sciences as a major course of study.

The department's courses present the many aspects of the mathematical sciences: as a means of structuring the world of knowledge, as an art form, as an enabler of other disciplines, and as a historical force. As a consequence, the department provides the requisite mathematical, computational, and statistical content and methodology for allied disciplines as well as three comprehensive major programs.

Resources for Nonmajors

The following courses are designed with nonmajors in mind:

QR 101 is intended for those students who need more preparation for college-level mathematics and science. It replaces MATH 055 and CS 102. Students who do not pass Lewis & Clark's quantitative reasoning exam should enroll in this course.

MATH 103 Perspectives in Mathematics, MATH 105 Perspectives in Statistics, and CS 107 Perspectives in Computer Science stress connections among contemporary mathematics, statistics, computer science, and modern society.

MATH 115 Elementary Functions allows students to explore and become comfortable with the functions used in introductory calculus and computer science courses.

MATH 123 Calculus & Statistics for Modeling the Life Sciences introduces foundational quantitative skills that are relevant to problem solving in the life sciences.

MATH 255 Statistical Concepts and Methods introduces the main ideas of modern statistics with applications to problems encountered in various disciplines, especially the natural sciences.

The Major Programs

The department supports three majors: one in mathematics, one in computer science and mathematics, and one in computer science.

Students intending to major in any of these programs should have four years of high school mathematics, including, at a minimum, two years of algebra, a course in geometry, and a course in precalculus mathematics (including analytical geometry and trigonometry). Most well-prepared students begin their college mathematics programs with calculus (MATH 131 Calculus I, MATH 132 Calculus II, or MATH 233 Calculus III) and their college computer science programs with CS 171 Computer

Science I. Students who have received Advanced Placement credit, or who have significant computer science experience, should consult with a member of the department for proper placement. For students without strong backgrounds in mathematics, the department offers MATH 115 Elementary Functions to prepare them for work in calculus and computer science.

Students majoring in mathematics may also earn a minor in computer science; otherwise, students may not earn more than one major or minor from the department.

Major Requirements: Computer Science

A minimum of 44 semester credits in the mathematical sciences numbered 171 and above,* including the following:

- CS 171 Computer Science I
- CS 172 Computer Science II
- CS 230 Computational Mathematics or MATH 132 Calculus II
- CS 383 Algorithm Design and Analysis
- One of the following:

CS 277	Computer Architecture and Assembly Languages
CS 293	Networks and Web Development
- MATH 255 Statistical Concepts and Methods
- CS 488 Software Development
- At least 16 additional semester credits in computer science numbered 200 or above.

Major Requirements: Computer Science and Mathematics

A minimum of 40 semester credits in the mathematical sciences numbered 171 and above,* including the following:

- CS 171 Computer Science I
- CS 172 Computer Science II
- CS 383 Algorithm Design and Analysis
- One of the following:

CS 277	Computer Architecture and Assembly Languages
CS 293	Networks and Web Development
- MATH 215 Discrete Mathematics
- MATH 225 Linear Algebra
- At least 4 additional semester credits in mathematics courses numbered 200 or above.
- At least 4 additional semester credits in mathematics courses numbered 300 or above.
- At least 8 additional semester credits in computer science courses numbered 200 or above*.

CS 230 Computational Mathematics does not count toward this major.

Major Requirements: Mathematics

A minimum of 36 semester credits in mathematics courses numbered 171 and above,* including the following:

- CS 171 Computer Science I
- MATH 215 Discrete Mathematics
- MATH 225 Linear Algebra
- MATH 233 Calculus III
- At least 16 additional semester credits at the 300 or 400* level, at least 12 of which must be in mathematics courses.

CS 230 Computational Mathematics does not count toward this major.

Minor Requirements: Computer Science

A minimum of 20 semester credits, including the following:

- Sixteen semester credits in computer science courses numbered 171 and above.*
- CS 230 Computational Mathematics or 4 semester credits in mathematics courses numbered 115 and above.

Minor Requirements: Mathematics

A minimum of 16 semester credits in mathematics courses numbered 200 and above,* including the following:

- MATH 215 Discrete Mathematics
- MATH 225 Linear Algebra
- At least 4 semester credits in mathematics at the 300 or 400* level.

**To apply MATH 490 Topics in Mathematics or CS 495 Topics in Computer Science to a major or minor requires consent of the department chair.*

Honors

The honors program in the mathematical sciences usually consists of either (a) a yearlong independent research project, or (b) a summer research project followed by one semester of independent study, culminating in an appropriate oral presentation and written form. After completing the 100- and 200-level courses required for one of the majors and enrolling in at least one course at the 300 or 400 level, an interested student with a cumulative GPA of 3.500 or higher, both in the major and overall, should consult the chair or the student's advisor concerning development and completion of a project.

Faculty

Paul T. Allen. Associate professor of mathematics. Geometric analysis, differential equations, mathematical relativity. PhD 2007, MS 2003 University of Oregon. BS 2001 University of Puget Sound.

Margot Black. Director of the Symbolic and Quantitative Resource Center. MS 2005 University of Oregon. BA 2003 Lewis & Clark College.

Naiomi T. Cameron. Associate Dean of the College of Arts and Sciences, associate professor of mathematics. Enumerative combinatorics, graph theory. PhD 2002, BS 1995 Howard University.

Yung-Pin Chen. Professor of statistics, chair of the Department of Mathematical Sciences. Statistics, sequential designs. Probability, stochastic processes. PhD 1994 Purdue University. BS 1984 National Chengchi University, Taiwan.

Peter Drake. Associate professor of computer science. Artificial intelligence/cognitive science. Programming languages. PhD 2002 Indiana University. MS 1995 Oregon State University. BA 1993 Willamette University.

Jeffrey S. Ely. Associate professor of computer science. Computer graphics, numerical analysis. PhD 1990, MS 1981, BS 1976 Ohio State University.

John W. Krussel. Associate dean of the College of Arts and Sciences, professor of mathematics. Graph theory, combinatorics, cryptography. PhD 1987, MS 1983 Colorado State University. BA 1977 Saint Louis University.

Jens Mache. Professor of computer science. Operating systems, computer architecture, parallel and distributed systems, computer networks. PhD 1998 University of Oregon. MS 1994 Southern Oregon University. Vordiplom 1992 Universitaet Karlsruhe.

Katherine Rock. Visiting assistant professor of mathematics. MS 2016, BS 2014 Portland State University.

Elizabeth A. Stanhope. Associate professor of mathematics. Differential geometry, spectral geometry. PhD 2002, AM 1999 Dartmouth College. BA 1995 Carleton College.

Iva Stavrov. Associate professor of mathematics. Differential geometry, algebraic topology. PhD 2003, MS 2001 University of Oregon. BS 1998 University of Belgrade.

Sweta Suryanarayan. Visiting assistant professor of mathematics. PhD 2012 University of Washington. MSc 2004 Indian Institute of Technology. BSc 2002 SIES College of Arts, Science and Commerce, University of Mumbai.

Computer Science Courses

CS 107 Perspectives in Computer Science

Faculty: Mathematical Sciences Faculty

Content: Introduction to computer science. Algorithmic thinking, the nature of electronic computers, and the place of information technology in society. Simple programming including variables, if statements, and loops.

Prerequisites: QR 101 or equivalent.

Usually offered: Annually, fall and spring semester.

Semester credits: 4.

CS 171 Computer Science I

Faculty: Mathematical Sciences Faculty
 Content: Basic techniques for solving problems amenable to solution through the use of a high-level computer programming language. Emphasis on solving a problem via a program and on the skills to write programs solving complex problems. Variables, data types, branches, loops, arrays, functional decomposition.
 Prerequisites: MATH 115 or equivalent.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 4.

CS 172 Computer Science II

Faculty: Drake
 Content: Data structures and algorithmic techniques that are fundamental in programming solutions to complex problems. Abstract data types, lists, stacks, queues, trees, graphs. Array-based and linked structures. Use and simple analysis of iterative and recursive algorithms. Introduction to object-oriented programming.
 Prerequisites: CS 171.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 4.

CS 211 Computer and Network Security

Faculty: Mache
 Content: Introduction to principles and practices of computer and network security. Topics may include cryptography, command line scripting, penetration testing, intrusion detection, incident response, analysis of attacks on web applications, mobile devices, internet of things.
 Prerequisites: CS 171.
 Usually offered: Alternate Years, fall semester.
 Semester credits: 4.

CS 230 Computational Mathematics

Faculty: Ely
 Content: Overview of the kinds of problems that arise in calculus and physics. Emphasis on computer solutions. Topics include differentiation, integration, linear systems, ordinary differential equations, approximation.
 Prerequisites: MATH 115 or equivalent. CS 171.
 Usually offered: Alternate Years, spring semester.
 Semester credits: 4.

CS 277 Computer Architecture and Assembly Languages

Faculty: Ely
 Content: Computer-design concepts and assembly languages. Topics chosen from the following: digital logic; arithmetic/logic units; instruction sets; memory addressing modes; parameter passing; macro facilities; binary representation of information; pointers.
 Prerequisites: CS 172.
 Usually offered: Alternate Years, spring semester.
 Semester credits: 4.

CS 293 Networks and Web Development

Faculty: Mache
 Content: Introduction to computer networks and web development. Topics may include internet protocols, client-server computing, distributed applications, databases.
 Prerequisites: CS 172.
 Usually offered: Annually, spring semester.
 Semester credits: 4.

CS 299 Independent Study

Faculty: Mathematical Sciences Faculty
 Content: Independent study topic to be arranged with instructor.
 Prerequisites: None.
 Restrictions: Sophomore standing and consent required.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 1-4.

CS 311 Computer and Network Security

Faculty: Mache
 Content: Principles and practices of computer and network security. Topics may include malicious software, pen testing, intrusion detection, incident response, cryptography, Web applications, mobile devices, Internet of Things.
 Prerequisites: CS 171.
 Usually offered: Alternate Years, fall semester.
 Semester credits: 4.

CS 367 Computer Graphics

Faculty: Ely
 Content: Two- and three-dimensional computer graphics. Line, circle, filling, windowing, clipping algorithms, three-dimensional perspective projections, hidden line removal, shading, light models.
 Prerequisites: CS 172. CS 230 or MATH 132. Familiarity with vectors and matrices recommended.
 Usually offered: Annually, fall semester.
 Semester credits: 4.

CS 369 Artificial Intelligence and Machine Learning

Faculty: Drake
 Content: Design and construction of intelligent computer systems. Agents and environments; blind, heuristic, and adversarial search; machine learning techniques including neural networks; philosophical issues including definitions of intelligence.
 Prerequisites: CS 172.
 Usually offered: Alternate Years, spring semester.
 Semester credits: 4.

CS 373 Programming Language Structures

Faculty: Mathematical Sciences Faculty
 Content: Organization, structure, syntax, and grammar of computer programming languages. Basic concepts and special-purpose facilities in several representative high-level languages. Manual and automatic memory management, control structures, scope of declarations, higher-order functions.
 Prerequisites: CS 172.
 Usually offered: Alternate Years, fall semester.
 Semester credits: 4.

CS 383 Algorithm Design and Analysis

Faculty: Mathematical Sciences Faculty
 Content: Introduction to the design and analysis of algorithms. Balanced binary search trees; bit vectors; hash tables; heaps; dynamic programming; algorithms including incremental, divide and conquer, greedy, graph.
 Prerequisites: CS 172. MATH 132 or CS 230.
 Usually offered: Annually, fall semester.
 Semester credits: 4.

CS 444 Internship/Practicum

Faculty: Mathematical Sciences Faculty
 Content: Practicum or internship in computer science.
 Prerequisites: None.
 Restrictions: Sophomore standing required.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 2.

CS 465 Theory of Computation

Faculty: Mathematical Science Faculty
 Content: Basic theoretical foundations of computer science including finite state and pushdown automata, Turing machines, computability, the halting problem, regular expressions, NP-completeness, the relationship between grammars and automata.
 Prerequisites: CS 172. MATH 215.
 Usually offered: Alternate Years, spring semester.
 Semester credits: 4.

CS 467 Advanced Computer Graphics

Faculty: Ely
 Content: Advanced three-dimensional computer graphics. Z-buffer algorithms, Phong smooth shading, ray tracing, texture mapping, spline patches.
 Prerequisites: CS 367.
 Usually offered: Alternate Years, spring semester.
 Semester credits: 4.

CS 488 Software Development

Faculty: Drake
 Content: Development of large software systems by teams of programmers. Problem specification, system design, testing, version control, design patterns. Teams of students work on a semester-long project for an external "customer."
 Prerequisites: CS 383.
 Restrictions: Junior standing required.
 Usually offered: Annually, spring semester.
 Semester credits: 4.

CS 495 Topics in Computer Science

Faculty: Mathematical Sciences Faculty
 Content: Determined by student and/or faculty interest. May continue topics from an existing course or explore new areas. May be taken three times for credit under different topics. Requires instructor consent.
 Prerequisites: CS-172.
 Restrictions: Sophomore standing required.
 Usually offered: Alternate Years, fall semester.
 Semester credits: 2-4.

CS 499 Independent Study

Faculty: Mathematical Sciences Faculty
 Content: Independent study topic to be arranged with instructor.
 Prerequisites: None.
 Restrictions: Sophomore standing and consent required.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 1-4.

Mathematics and Statistics Courses**MATH 103 Perspectives in Mathematics**

Faculty: Mathematical Sciences Faculty
 Content: For nonmajors. Selected topics illustrating mathematics as a way of representing and understanding patterns and structures, as an art, as an enabler in other disciplines, and as a historical force. Emphasis changes from semester to semester, reflecting the expertise and interests of the faculty member teaching the course. For further information consult the appropriate faculty member before registration.
 Prerequisites: QR 101 or equivalent.
 Usually offered: Annually, fall semester.
 Semester credits: 4.

MATH 105 Perspectives in Statistics

Faculty: Mathematical Sciences Faculty
 Content: Data analysis, data production, statistical inference. Data analysis: methods and ideas for organizing and describing data using graphs, numerical summaries, and other statistical descriptions. Data production: methods for selecting samples and designing experiments to produce data that can give clear answers to specific questions. Statistical inference: methods for moving beyond the data to draw conclusions about some wider universe.
 Prerequisites: QR 101 or equivalent.
 Usually offered: Annually, fall semester.
 Semester credits: 4.

MATH 115 Elementary Functions

Faculty: Mathematical Sciences Faculty
 Content: The basic functions encountered in calculus, discrete mathematics, and computer science: polynomial, rational, exponential, logarithmic, and trigonometric functions and their inverses. Graphs of these functions, their use in problem solving, their analytical properties. May not be taken for credit if AP Calculus credit has been granted.
 Prerequisites: QR 101 or equivalent.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 4.

MATH 123 Calculus & Statistics for Modeling the Life Sciences

Faculty: Stanhope
 Content: Use of case studies to introduce students to foundational quantitative skills that are relevant to problem solving in the life sciences. Included are topics in calculus, probability, statistics, and algorithms.
 Prerequisites: MATH 115.
 Usually offered: Annually, fall semester.
 Semester credits: 4.

MATH 131 Calculus I

Faculty: Mathematical Sciences Faculty
 Content: Basic analytical and quantitative reasoning and problem-solving skills that depend on the concept of the limit. Continuity, the derivative and its applications, the Fundamental Theorem of Calculus, introduction to the definite integral with applications. May not be taken for credit if AP Calculus credit has been granted.
 Prerequisites: MATH 115 or equivalent.
 Usually offered: Annually, fall and spring semester.
 Semester credits: 4.

MATH 132 Calculus II

Faculty: Mathematical Sciences Faculty

Content: Further development of the definite integral including techniques of integration, applications of the definite integral, indeterminate forms, and improper integrals. Sequences, series of constants, power series, Taylor polynomials and series, introduction to elementary differential equations. May not be taken for credit if AP Calculus BC credit has been granted.

Prerequisites: MATH 131 or equivalent.

Usually offered: Annually, fall and spring semester.

Semester credits: 4.

MATH 215 Discrete Mathematics

Faculty: Mathematical Sciences Faculty

Content: Basic techniques of abstract formal reasoning and representation used in the mathematical sciences. First order logic, elementary set theory, proof by induction and other techniques, enumeration, relations and functions, graphs, recurrence relations.

Prerequisites: MATH 132 or equivalent.

Usually offered: Annually, fall and spring semester.

Semester credits: 4.

MATH 225 Linear Algebra

Faculty: Mathematical Sciences Faculty

Content: Basic skills and concepts that evolve from the study of systems of linear equations. Systems of linear equations, Euclidean vector spaces and function spaces, linear transformations, matrices and determinants, inner product spaces, eigenvalue problems, symmetric transformations.

Prerequisites: MATH 132 or equivalent.

Usually offered: Annually, fall and spring semester.

Semester credits: 4.

MATH 233 Calculus III

Faculty: Mathematical Sciences Faculty

Content: Basic analytical and quantitative skills in the theory of functions of several variables. Partial differentiation; gradients; multiple integrals; theorems of Green, Gauss, and Stokes.

Prerequisites: MATH 132 or equivalent.

Usually offered: Annually, fall and spring semester.

Semester credits: 4.

MATH 235 Differential Equations

Faculty: Mathematical Sciences Faculty

Content: Introduction to theory, methods, and applications of differential equations, emphasizing the analysis of dynamical systems. Elementary modeling, numerical techniques, solutions to linear systems, qualitative analysis of nonlinear systems, nonlinear oscillators, introduction to advanced topics.

Prerequisites: MATH 132 or equivalent.

Usually offered: Annually, fall semester.

Semester credits: 4.

MATH 244 Math Practicum

Faculty: Mathematical Sciences Faculty

Content: Tutoring opportunities (two to four hours onsite per week) at community schools to include one-on-one tutoring or classroom aid for site supervisor. Written reports and consultation with instructor required during semester. Specific math courses or grade levels to be determined by student, site supervisor, and instructor. Credit-no credit. May be taken twice for credit with at most 2 credits counted toward math major.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Annually, fall and spring semester.

Semester credits: 1-4.

MATH 255 Statistical Concepts and Methods

Faculty: Chen

Content: Introduction to principal statistical concepts and methods with emphasis on data. Statistical thinking, the application of statistical methods to other disciplines, and the communication of statistics, both verbally and in writing. Exploratory data analysis, random variables, regression analysis, data production, and statistical inference. Mathematical tools and skills used to address problems posed by collecting, analyzing, and modeling data.

Prerequisites: MATH 131 or equivalent.

Usually offered: Annually, spring semester.

Semester credits: 4.

MATH 281 Putnam Exam Preparation

Faculty: Stavrov

Content: Emphasis on problem-solving skills required for success on the Putnam Exam. Participation in the exam is required to earn credit. Credit-no credit. May be taken twice for credit.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Annually.

Semester credits: 1.

MATH 282 Modeling Competition Preparation

Faculty: Stanhope

Content: Emphasis on mathematical modeling skills required for success in the COMAP Mathematical Modeling Competition and Interdisciplinary Modeling Competition. Participation in the competition is required to earn credit. Credit-no credit. May be taken twice for credit.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Annually, spring semester.

Semester credits: 1.

MATH 299 Independent Study

Faculty: Mathematical Sciences Faculty

Content: Independent study topic to be arranged with instructor.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Annually, fall and spring semester.

Semester credits: 1.

MATH 305 Calculus IV With Applications to the Physical Sciences

Faculty: Allen

Content: Using techniques of multivariate calculus to derive and study the classical linear partial differential equations. Topics include the calculus of variations, initial and boundary value problems, the method of separation of variables, Hilbert spaces, and Fourier series. Additional topics may include special functions, the Fourier transform, and Green's functions. Math 235 may be taken concurrently with permission of instructor.

Prerequisites: MATH 233, MATH 235.

Restrictions: Sophomore standing required.

Usually offered: Annually, spring semester.

Semester credits: 4.

MATH 315 Number Theory

Faculty: Mathematical Sciences Faculty

Content: Divisibility properties of the integers, unique factorization, linear Diophantine equations, congruences, Fermat's and Wilson's theorems, arithmetic functions. Other topics selected from the following: primitive roots and indices, quadratic reciprocity, the theory of prime numbers, continued fractions, sums of squares, analytic number theory.

Prerequisites: MATH 215.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 325 Combinatorics

Faculty: Cameron, Krussel

Content: Introduction to combinatorial theory, including one or more of the following: enumeration, algebraic enumeration, optimization, graph theory, coding theory, design theory, finite geometries, Latin squares, posets, lattices, Polya counting, Ramsey theory.

Prerequisites: MATH 215 and MATH 225.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 4.

MATH 341 Real Analysis

Faculty: Stanhope, Stavrov

Content: Development of the ability to understand, construct, and write proofs in analysis. Topics include limits, continuity, differentiation, integration, metric spaces, applications, and generalizations, from an axiomatic perspective.

Prerequisites: MATH 215.

Restrictions: Sophomore standing required.

Usually offered: Annually, fall semester.

Semester credits: 4.

MATH 345 Numerical Analysis

Faculty: Ely

Content: The theoretical basis, error analysis, and practical techniques of numerical computations. Topics chosen from the following: solutions of systems of linear equations, solutions of nonlinear equations, numerical integration and differentiation, solutions of ordinary differential equations, eigenvalue problems, interpolation, approximation.

Prerequisites: CS 171. MATH 225. MATH 233.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 4.

MATH 351 Linear Models

Faculty: Chen

Content: As an introduction to statistical modeling, this course surveys general model-building methods and studies linear regression analysis that is widely employed for modeling the relationship between a response variable and a set of explanatory variables. It aims to blend both theory and applications to gain an understanding of the concepts and methods for applying statistical modeling techniques in a wide variety of disciplines.

Prerequisites: ECON 103, PSY 200, MATH 105, MATH 123, or MATH 255.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 355 Geometry

Faculty: Mathematical Sciences Faculty

Content: Concepts of geometry encompassing both Euclidean and non-Euclidean geometries. Parallelism, distance, angles, triangles, other geometric notions studied from the viewpoint of logic and foundations, transformations or differential geometry.

Prerequisites: MATH 215.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 358 Topology

Faculty: Allen, Stanhope, Stavrov

Content: Concepts of topology. Set theory, metric spaces, topological spaces, continuity, compactness, connectedness, and topological equivalence.

Prerequisites: MATH 215.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 365 Complex Variables

Faculty: Mathematical Sciences Faculty

Content: Concepts of complex analysis. Complex number system, analytic functions, integration of functions of a complex variable, power series representation, conformal mappings, residue theory.

Prerequisites: Math 233.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 421 Abstract Algebra I

Faculty: Cameron, Krussel

Content: A two-semester sequence in abstract algebraic systems. Structure of groups, subgroups, quotient groups, homomorphisms, Fundamental Isomorphism Theorems, rings, ideals, integral domains, polynomial rings, matrix rings, fields, Galois theory, advanced topics in linear algebra.

Prerequisites: MATH 215 and MATH 225.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 422 Abstract Algebra II

Faculty: Cameron, Krussel

Content: A two-semester sequence in abstract algebraic systems. Structure of groups, subgroups, quotient groups, homomorphisms, Fundamental Isomorphism Theorems, rings, ideals, integral domains, polynomial rings, matrix rings, fields, Galois theory, advanced topics in linear algebra.

Prerequisites: MATH 215 and MATH 225.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 4.

MATH 442 Advanced Topics in Analysis and Topology

Faculty: Stanhope, Stavrov, Allen

Content: Multivariable real analysis with applications to differential topology. Topics selected from fixed-point theorems, implicit and inverse function theorems, integration, manifolds, homotopy, and homology.

Prerequisites: MATH 225, MATH 233, and MATH 341.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 4.

MATH 444 Practicum

Faculty: Mathematical Sciences Faculty

Content: Internship or practicum to be arranged with instructor.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Annually, fall and spring semester.

Semester credits: 1-4.

MATH 451 Probability and Statistics I

Faculty: Chen

Content: A two-semester sequence in the theory of probability and mathematical statistics. Elementary probability, discrete and continuous random variables, distributions, limit theorems, point estimation, hypothesis testing, linear models, analysis of variance, nonparametric statistics.

Prerequisites: MATH 215 and MATH 233.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

MATH 452 Probability and Statistics II

Faculty: Chen

Content: A two-semester sequence in the theory of probability and mathematical statistics. Elementary probability, discrete and continuous random variables, distributions, limit theorems, point estimation, hypothesis testing, linear models, analysis of variance, nonparametric statistics.

Prerequisites: MATH 215 and MATH 233.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 4.

MATH 490 Topics in Mathematics

Faculty: Mathematical Sciences Faculty

Content: Determined by student and/or faculty interest. May continue topics from an existing course or explore new areas. May be taken three times for credit under different topics.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Alternate Years, fall and spring semester.

Semester credits: 4.

MATH 499 Independent Study

Faculty: Mathematical Sciences faculty

Content: Independent study topic to be arranged with instructor.

Prerequisites: None.

Restrictions: Sophomore standing and consent required.

Usually offered: Annually, fall and spring semester.

Semester credits: 1-4.

Quantitative Reasoning Courses**QR 101 Foundations of Quantitative Reasoning**

Faculty: Black

Content: Students will apply mathematics, statistics, and algebra to quantitatively analyze, model, and solve problems in authentic contexts with a focus on effectively reporting the results and conclusions.

Topics include units, dimensional analysis, estimation, percent change, proportional reasoning, linear and exponential modeling, systems of equations, charts and graphs, descriptive statistics, logarithmic scale, linear regression, correlation, and what-if analysis. Emphasis on using computational tools.

Prerequisites: ALEKS score of 30 or above.

Usually offered: Annually, fall and spring semester.

Semester credits: 4.