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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:

CS 102 Quantitative Reasoning is intended for those students who need more preparation for college-level mathematics and science. It replaces MATH 055. 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 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 in calculus or computer science 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 with interest in a professional career in the mathematical sciences should plan their curriculum to meet specific goals.

For graduate study in mathematics:

MATH 421 Abstract Algebra I  
MATH 422 Abstract Algebra II  
MATH 441 Advanced Calculus I  
MATH 442 Advanced Calculus II

These students should take as many additional upper-division mathematics courses as possible. They should also be aware that many graduate programs require a reading knowledge of one or two foreign languages, usually chosen from among French, German, and Russian.

For graduate study in computer science:

CS 465 Theory of Computation

For graduate study in statistics or a career in actuarial science:

MATH 345 Numerical Analysis  
MATH 451 Probability and Statistics I  
MATH 452 Probability and Statistics II

For teaching in secondary or middle school:

MATH 315 Number Theory  
MATH 355 Geometry  
MATH 421 Abstract Algebra I  
MATH 451 Probability and Statistics I
For a career in industry or applied mathematics:

MATH 255  Statistical Concepts and Methods
MATH 345  Numerical Analysis
MATH 365  Complex Variables

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
• CS 383 Algorithm Design and Analysis
• One of the following:
  CS 277  Computer Architecture and Assembly Languages
  CS 393  Computer Networks
• MATH 255 Statistical Concepts and Methods
• At least 20 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 393  Computer Networks
• MATH 215 Discrete Mathematics
• MATH 225 Linear Algebra
• At least 8 additional semester credits in mathematics courses numbered 200 or above.
• At least 8 additional semester credits in computer science courses at the 300 or 400* level.

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 171 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 a one-semester 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**


**Computer Science**

**CS 102 Quantitative Reasoning**

Faculty: Ely, Schleef.

Content: Cultivation of logical thinking and problem-solving skills, using mathematical models to analyze problems and cases. Focus on effectively reporting results and conclusions. Application of appropriate computational techniques. Laboratory required, but credits do not count toward graduation.

Prerequisites: None.

Usually offered: Annually, fall and spring semester.

Semester credits: 2.

**CS 107 Perspectives in Computer Science**

Faculty: Mathematical Sciences Faculty.

Content: Introduction to computer science. Topics chosen from the following: programming languages, digital logic and computer architecture, algorithms. Programming concepts including applications of loops, assignment and if statements, arrays, user-defined functions. Emphasis on the writing of programs illustrating these concepts. Students who have received credit (including transfer and advanced standing credit) for CS 171 or its equivalent may not register for this course.

Prerequisites: CS 102, MATH 055, 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: Mathematical Science Faculty.
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 or consent of instructor.
Usually offered: Annually, fall and spring semester.
Semester credits: 4.

CS 230 Computational Mathematics
Content: Overview of the kinds of problems that arise in calculus and physics. Emphasis on computer solutions. Topics include differentiation, integration, nonlinear equations, linear systems, ordinary differential equations, approximation, curve fitting.
Prerequisites: MATH 115 or equivalent. CS 171.
Usually offered: Annually.
Semester credits: 4.

CS 277 Computer Architecture and Assembly Languages
Content: Computer design concepts and assembly languages. Topics chosen from the following: digital logic; arithmetic/logic unit design; bus structures; VLSI implementation; SIMD, MIMD, and RISC architectures; instruction sets; memory addressing modes; parameter passing; macro facilities.
Prerequisites: CS 172.
Usually offered: Annually.
Semester credits: 4.

CS 363 Operating Systems
Content: Basic principles, policies, design issues, and construction of computer operating systems. Memory management, scheduling, synchronization of concurrent processes, input-output.
Prerequisites: CS 277.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

CS 367 Computer Graphics
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 equivalent.
Familiarity with trigonometry, vectors helpful.
Restrictions: Sophomore standing required.
Usually offered: Annually.
Semester credits: 4.

CS 369 Artificial Intelligence
Content: Design and construction of intelligent computer systems. Agents and environments; blind and informed search; heuristics; game play, minimax, and alpha-beta pruning; robotics; machine learning; philosophical issues including definitions of intelligence.
Prerequisites: CS 172.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

CS 373 Programming Language Structures
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, macros, object-oriented programming.
Prerequisites: CS 172.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.
CS 383 Algorithm Design and Analysis

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 215 or CS 230.
Restrictions: Sophomore standing required.
Usually offered: Annually.
Semester credits: 4.

CS 393 Computer Networks

Content: The structure, implementation, and theoretical underpinnings of computer networks. Topic areas include Internet protocols, client-server computing, distributed applications.
Prerequisites: CS 172.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

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.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

CS 467 Advanced Computer Graphics

Prerequisites: CS 367.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

CS 487 Advanced Algorithms

Content: Advanced study of algorithm design and implementation. Preparation for programming competitions. Topics chosen from the following: dynamic programming, graph algorithms, network flow and matching, backtracking, constructing all subsets, constructing all permutations, high-precision arithmetic, geometric algorithms.
Prerequisites: CS 383.
Restrictions: Sophomore standing required.
Usually offered: Annually.
Semester credits: 4.

CS 488 Software Development

Faculty: Drake.
Content: Development of large software systems by teams of programmers. Problem specification, system design, testing, software frameworks, design patterns.
Prerequisites: CS 373 or CS 383.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

CS 495 Topics in Computer Science

Faculty: Mathematical Science 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: Consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

Mathematics and Statistics

MATH 055 Review of Algebra

Faculty: Mathematical Science Faculty.
Content: Solving linear, absolute value, quadratic, exponential, and logarithmic equations. Introduction to functions and their graphs.
Conic sections, polynomial operations including factoring and rules for exponents, rational and radical expressions, inequalities and systems of equations. Credit-no credit. Not counted toward the 128 semester credits needed for graduation.
Prerequisites: None.
Usually offered: Annually, fall, spring, and summer.
Semester credits: 4.
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: CS 102, MATH 055, 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. Note: Students who have received credit for ECON 103, PSY 200, or AP Statistics may not take this course for credit.
Prerequisites: CS 102, MATH 055, 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: CS 102, MATH 055, or equivalent.
Usually offered: Annually, fall and spring semester.
Semester credits: 4.

MATH 131 Calculus I

Faculty: Mathematical Science 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 Science 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 Science 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 Science 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 Science 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.
Semester credits: 4.

MATH 235 Differential Equations
Faculty: Mathematical Science Faculty.
Prerequisites: MATH 132 or equivalent.
Usually offered: Annually.
Semester credits: 4.

MATH 244 Math Practicum
Faculty: Mathematical Science 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
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.
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.
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.
Prerequisites: MATH 233. MATH 235 (may be taken concurrently).
Restrictions: Sophomore standing required.
Usually offered: Annually, spring semester.
Semester credits: 4.
MATH 315 Number Theory
Faculty: Mathematical Science 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 or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

MATH 325 Combinatorics
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 or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
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.
Semester credits: 4.

MATH 355 Geometry
Faculty: Mathematical Science 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 or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

MATH 358 Topology
Prerequisites: MATH 215 or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

MATH 365 Complex Variables
Faculty: Mathematical Science 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 or consent of instructor.
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, or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.
MATH 422 Abstract Algebra II

Faculty: Cameron, Krussell.
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, or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

MATH 441 Advanced Calculus I

Content: A two-semester sequence in the theory of the calculus. Development of the ability to understand, construct, and write proofs in analysis. Limits, continuity, differentiation, integration, applications, generalizations.
Prerequisites: MATH 215.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

MATH 442 Advanced Calculus II

Faculty: Stanhope, Stavrov.
Content: A two-semester sequence in the theory of the calculus. Development of the ability to understand, construct, and write proofs in analysis. Limits, continuity, differentiation, integration, applications, generalizations.
Prerequisites: MATH 225, MATH 233, and MATH 441, or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 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, or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
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, or consent of instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years.
Semester credits: 4.

MATH 490 Topics in Mathematics

Faculty: Mathematical Science 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.
Semester credits: 4.