The Cuban Revolution recently celebrated its fiftieth anniversary. Offers a retrospective of a Revolution entering “middle age” and its prospects for the future. Topics include United States-Cuban relations, economic and social justice versus political liberty, gender and race relations, and literature and film in a socialist society. (Same as History 356.)


Mathematics

Adam B. Levy, Department Chair
Suzanne M. Theberge, Senior Department Coordinator

Associate Professor: Jennifer Taback
Assistant Professor: Thomas Pietraho
Visiting Faculty: Michael King, Mohammad Tajdari
Fellow: Noah Kieserman

Requirements for the Major in Mathematics

A major consists of at least eight courses numbered 200 or higher, including Mathematics 200 and 201 (or their equivalents), and a course numbered in the 300s. Students who have already mastered the material in Mathematics 200 or 201 may substitute a more advanced course after receiving approval from the department chair. Courses must be passed with a C- or better (including Credit) to count toward the major.

A student must submit a planned program of courses to the department when he or she declares a major. That program should include both theoretical and applied mathematics courses, and it may be changed later with the approval of the departmental advisor.

The requirement of a 300-level course is meant to ensure that all majors have sufficient experience in at least one specific area of mathematics. Those areas are algebra (Mathematics 201, 262, and 302); analysis (Mathematics 233, 263, and 303); applied mathematics (Mathematics 224, 264, and 304); probability and statistics (Mathematics 225, 265, and 305); and geometry (Mathematics 247 and 307).

In exceptional circumstances, a student may substitute a quantitative course from another department for one of the eight mathematics courses required for the major, but such a substitution must be approved in advance by the department. Without specific departmental approval, no course that counts toward another department’s major or minor may be counted toward a mathematics major or minor.

Majors who have demonstrated that they are capable of intensive advanced work are encouraged to undertake independent study projects. With the prior approval of the department, such a project counts toward the major requirement and may lead to graduation with honors in mathematics.

Requirements for the Minor in Mathematics

A minor in mathematics consists of a minimum of four courses numbered 200 or higher. Courses must be passed with a C- or better (including Credit) to count toward the minor.
Interdisciplinary Majors
The department participates in interdisciplinary programs in computer science and mathematics and mathematics and economics. See pages 209 and 212.

Recommended Courses
Listed below are some of the courses recommended to students with the indicated interests.

For secondary school teaching:

For graduate study:
Mathematics 200, 201, 233, 262, 263, and at least one course numbered in the 300s.

For engineering and applied mathematics:
Mathematics 201, 204 (same as Biology 174), 224, 225, 233, 244, 258, 264, 265, 304.

For mathematical economics and econometrics:
Mathematics 201 or 225, 229, 244, 258, 263, 265, 304, 305, and Economics 316.

For statistics:
Mathematics 201, 224, 225, 235, 244, 265, 305.

For computer science:
Computer Science 231, 289; Mathematics 200, 201, 225, 229, 244, 258, 262, 265.

For operations research and management science:
Mathematics 200, 201, 225, 229, 258, 265, 305, and Economics 316.

Introductory, Intermediate, and Advanced Courses

60a - MCSR. Introduction to College Mathematics. Spring 2010. The Department.
A gentle introduction to some of the most important and interesting ideas in mathematics. An opportunity to discover the mathematics inherent in the world around us. This course, in conjunction with Mathematics 155 or 161, is intended as a one-year introduction to mathematics and is recommended for those students who intend to take only one year of college mathematics.

155a - MCSR. Introduction to Statistics and Data Analysis. Every fall. Fall 2009. Rosemary Roberts.
A general introduction to statistics in which students learn to draw conclusions from data using statistical techniques. Examples are drawn from many different areas of application. The computer is used extensively. Topics include exploratory data analysis, planning and design of experiments, probability, one and two sample t-procedures, and simple linear regression. Not open to students who have credit for Mathematics 165, Psychology 252, or Economics 257.

161a - MCSR. Differential Calculus. Every semester. The Department.
Functions, including the trigonometric, exponential, and logarithmic functions; the derivative and the rules for differentiation; the anti-derivative; applications of the derivative and the anti-derivative. Four to five hours of class meetings and computer laboratory sessions per week, on average. Open to students who have taken at least three years of mathematics in secondary school.
165a - MCSR. Biostatistics. Every spring. Spring 2010. The Department.

An introduction to the statistical methods used in the life sciences. Emphasizes conceptual understanding and includes topics from exploratory data analysis, the planning and design of experiments, probability, and statistical inference. One and two sample t-procedures and their non-parametric analogs, one-way ANOVA, simple linear regression, goodness of fit tests, and the chi-square test for independence are discussed. Four to five hours of class meetings and computer laboratory sessions per week, on average. Not open to students who have credit for Mathematics 155, Psychology 252, or Economics 257.

171a - MCSR. Integral Calculus. Every semester. The Department.

The definite integral; the Fundamental theorems; improper integrals; applications of the definite integral; differential equations; and approximations including Taylor polynomials and Fourier series. Four to five hours of class meetings and computer laboratory sessions per week, on average.

Prerequisite: Mathematics 161.

172a - MCSR. Integral Calculus, Advanced Section. Fall 2009. The Department.

A review of the exponential and logarithmic functions, techniques of integration, and numerical integration. Improper integrals. Approximations using Taylor polynomials and infinite series. Emphasis on differential equation models and their solutions. Four to five hours of class meetings and computer laboratory sessions per week, on average. Open to students whose backgrounds include the equivalent of Mathematics 161 and the first half of Mathematics 171. Designed for first-year students who have completed an AB Advanced Placement calculus course in their secondary schools.

Prerequisite: Mathematics 161 or 172.

181a - MCSR. Multivariate Calculus. Every semester. The Department.

Multivariate calculus in two and three dimensions. Vectors and curves in two and three dimensions; partial and directional derivatives; the gradient; the chain rule in higher dimensions; double and triple integration; polar, cylindrical, and spherical coordinates; line integration; conservative vector fields; and Green’s theorem. Four to five hours of class meetings and computer laboratory sessions per week, on average.

Prerequisite: Mathematics 171 or 172.

200a - MCSR. Introduction to Mathematical Reasoning. Every semester. The Department.

An introduction to logical deductive reasoning, mathematical proof, and the fundamental concepts of higher mathematics. Specific topics include set theory, induction, infinite sets, permutations, and combinations. An active, guided discovery classroom format.

Prerequisite: Mathematics 181 or permission of the instructor.

201a - MCSR. Linear Algebra. Every semester. The Department.

Topics include vectors, matrices, vector spaces, inner product spaces, linear transformations, eigenvalues and eigenvectors, and quadratic forms. Applications to linear equations, discrete dynamical systems, Markov chains, least-squares approximation, and Fourier series. Formerly Mathematics 222.

Prerequisite: Mathematics 181 or permission of the instructor.

204a - MCSR. Biomathematics. Every fall. Fall 2009. Mary Lou Zeeman.

A study of mathematical methods driven by questions in biology. Biological questions are drawn from a broad range of topics, including disease, ecology, genetics, population dynamics, neurobiology, endocrinology and biomechanics. Mathematical methods include compartmental models, matrices, linear transformations, eigenvalues, eigenvectors, matrix iteration and simulation; ODE models and simulation, stability analysis, attractors, oscillations
and limiting behavior, mathematical consequences of feedback, and multiple time-scales. Three hours of class meetings and two hours of computer laboratory sessions per week. Within the biology major, this course may count as the mathematics credit or as biology credit, but not both. Students are expected to have taken a year of high school or college biology prior to taking this course. Formerly Mathematics 174. (Same as Biology 174.)

Prerequisite: Mathematics 161 or permission of the instructor.

224a - MCSR. **Applied Mathematics: Ordinary Differential Equations.** Every spring. Spring 2010. The Department.

A study of some of the ordinary differential equations that model a variety of systems in the natural and social sciences. Classical methods for solving differential equations with an emphasis on modern, qualitative techniques for studying the behavior of solutions to differential equations. Applications to the analysis of a broad set of topics, including population dynamics, competitive economic markets, and design flaws. Computer software is used as an important tool, but no prior programming background is assumed.

Prerequisite: Mathematics 181 or permission of the instructor.


A study of the mathematical models used to formalize nondeterministic or “chance” phenomena. General topics include combinatorial models, probability spaces, conditional probability, discrete and continuous random variables, independence and expected values. Specific probability densities, such as the binomial, Poisson, exponential, and normal, are discussed in depth.

Prerequisite: Mathematics 181 or permission of the instructor.

227a - MCSR. **Elementary Topics in Topology.** Every other spring. Spring 2010. The Department.

Topology studies properties of geometric objects that do not change when the object is deformed. The course covers knot theory, surfaces, and other elementary areas of topology.

Prerequisite: Mathematics 200 or permission of the instructor.

229a - MCSR. **Optimization.** Every other spring. Spring 2011. The Department.

A study of optimization problems arising in a variety of situations in the social and natural sciences. Analytic and numerical methods are used to study problems in mathematical programming, including linear models, but with an emphasis on modern nonlinear models. Issues of duality and sensitivity to data perturbations are covered, and there are extensive applications to real-world problems.

Prerequisite: Mathematics 181 or permission of the instructor.

232a - MCSR. **Number Theory.** Every other fall. Fall 2010. The Department.

A standard course in elementary number theory, which traces the historical development and includes the major contributions of Euclid, Fermat, Euler, Gauss, and Dirichlet. Prime numbers, factorization, and number-theoretic functions. Perfect numbers and Mersenne primes. Fermat’s theorem and its consequences. Congruences and the law of quadratic reciprocity. The problem of unique factorization in various number systems. Integer solutions to algebraic equations. Primes in arithmetic progressions. An effort is made to collect along the way a list of unsolved problems.

Prerequisite: Mathematics 200 or permission of the instructor.
233a - MCSR. Functions of a Complex Variable. Every other fall. Fall 2009. THOMAS PIETRAHO.

The differential and integral calculus of functions of a complex variable. Cauchy’s theorem and Cauchy’s integral formula, power series, singularities, Taylor’s theorem, Laurent’s theorem, the residue calculus, harmonic functions, and conformal mapping.

Prerequisite: Mathematics 181 or permission of the instructor.

235a. Exploratory Multivariate Data Analysis. Every other fall. Fall 2010. THE DEPARTMENT.

Almost all data collected by researchers is multivariate. An introduction to the theory and techniques of exploratory multivariate data analysis. Topics include graphical techniques, scientific visualization, discriminant analysis, principle components, multi-dimensional scaling, classification, phylogeny trees and genomics, cluster analysis, and data mining. Students learn how to use the statistical system R.

Prerequisite: Mathematics 201 (formerly Mathematics 222) or permission of the instructor.

244a - MCSR. Numerical Methods. Every other spring. Spring 2010. THE DEPARTMENT.

An introduction to the theory and application of numerical analysis. Topics include approximation theory, numerical integration and differentiation, iterative methods for solving equations, and numerical analysis of differential equations.

Prerequisite: Mathematics 201 (formerly Mathematics 222) or permission of the instructor.

247a - MCSR. Geometry. Every other spring. Spring 2011. THE DEPARTMENT.


Prerequisite: Mathematics 200 or permission of the instructor.

258a - MCSR. Combinatorics and Graph Theory. Every other spring. Spring 2011. THE DEPARTMENT.

An introduction to combinatorics and graph theory. Topics to be covered may include enumeration, matching theory, generating functions, partially ordered sets, Latin squares, designs, and graph algorithms.

Prerequisite: Mathematics 200 or permission of the instructor.

262a - MCSR. Introduction to Algebraic Structures. Every year. Fall 2009. JENNIFER TABACK.

A study of the basic arithmetic and algebraic structure of the common number systems, polynomials, and matrices. Axioms for groups, rings, and fields, and an investigation into general abstract systems that satisfy certain arithmetic axioms. Properties of mappings that preserve algebraic structure.

Prerequisite: Mathematics 200 and 201 (formerly Mathematics 222), or permission of the instructor.

263a - MCSR. Introduction to Analysis. Every year. Spring 2010. THE DEPARTMENT.

Emphasizes proof and develops the rudiments of mathematical analysis. Topics include an introduction to the theory of sets and topology of metric spaces, sequences and series, continuity, differentiability, and the theory of Riemann integration. Additional topics may be chosen as time permits.

Prerequisite: Mathematics 200 or a 200-level mathematics course approved by the instructor.
Courses of Instruction

A study of some of the partial differential equations that model a variety of systems in the natural and social sciences. Classical methods for solving partial differential equations, with an emphasis where appropriate on modern, qualitative techniques for studying the behavior of solutions. Applications to the analysis of a broad set of topics, including air quality, traffic flow, and imaging. Computer software is used as an important tool, but no prior programming background is assumed.
Prerequisite: Mathematics 201 (formerly Mathematics 222) and 224, or permission of the instructor.

An introduction to the fundamentals of mathematical statistics. General topics include likelihood methods, point and interval estimation, and tests of significance. Applications include inference about binomial, Poisson, and exponential models, frequency data, and analysis of normal measurements.
Prerequisite: Mathematics 201 (formerly Mathematics 222) and 225, or permission of the instructor.


Introduction to rings and fields. Vector spaces over arbitrary fields. Additional topics may include Galois theory, algebraic number theory, finite fields, and symmetric functions.
Prerequisite: Mathematics 262 or permission of the instructor.

One or more selected topics from analysis. Possible topics include geometric measure theory, Lebesque general measure and integration theory, Fourier analysis, Hilbert and Banach space theory, and spectral theory.
Prerequisite: Mathematics 201 (formerly Mathematics 222) and 263, or permission of the instructor.

304a. Advanced Topics in Applied Mathematics. Every other fall. Fall 2010. The Department.
One or more selected topics in applied mathematics. Material selected from the following: Fourier series, partial differential equations, integral equations, optimal control, bifurcation theory, asymptotic analysis, applied functional analysis, and topics in mathematical physics.
Prerequisite: Mathematics 200, 201 (formerly Mathematics 222), and 224, or permission of the instructor.

One or more specialized topics in probability and statistics. Possible topics include regression analysis, nonparametric statistics, logistic regression, and other linear and nonlinear approaches to modeling data. Emphasis is on the mathematical derivation of the statistical procedures and on the application of the statistical theory to real-life problems.
Prerequisite: Mathematics 201 (formerly Mathematics 222) and 265, or permission of the instructor.

A survey of affine, projective, and non-Euclidean geometries in two-dimensions, unified by the transformational viewpoint of Klein’s Erlanger Program. Special focus will be placed
on conic sections. Additional topics: complex numbers in Euclidean geometry, quaternions in three-dimensional geometry, and the geometry of four-dimensional space-time in special relativity. Mathematics 247 is helpful but not required.

Prerequisite: Mathematics 200 and 201 (formerly Mathematics 222), or permission of the instructor.

401a–404a. Advanced Independent Study and Honors in Mathematics. The Department.

Music

Mary Hunter, Department Chair
Linda Marquis, Senior Department Coordinator

Professors: Robert K. Greenlee, Mary Hunter, Cristle Collins Judd
Associate Professors: James W. McCalla, Vineet Shende
Senior Lecturer: Anthony F. Antolini
Lecturers: Frank Mauceri, John Morneau, Roland Vazquez, Christopher Watkinson
Visiting Faculty: Anthony Perman

Requirements for the Major in Music

The music major normally consists of ten academic courses and two performance credits. Most majors follow one of the tracks indicated in the “Sample Majors” listed below, but students are also invited to design a major to suit their own needs. No more than two 100-level courses in addition to Music 101, 131, and 151 may be counted toward the major, and two 300-level courses in addition to Music 451 are normally required of all majors. Honors work normally adds one extra course to the standard ten, and its second semester counts as the senior independent study.

The process for declaring the major is as follows: (1) The student consults with a member of the music faculty as early in the individual’s college career as possible. (2) Before declaring a major, the student proposes a list of courses that fulfill the major, or identifies a sample major to follow by submitting a list or sample major announcement to the music department chair or to another member of the department. (3) Upon departmental approval of the list of courses or the particular track, the major declaration is signed by the department chair. Subsequent alterations to this list of courses are possible only in consultation with the chair of the department or another member of the music faculty.

Sample Sequences of Courses for the Music Major

General Music Major

Music 101, 131 or 211, 151, 203, 302, and 451.
Four electives, including two 200-level courses and one 300-level course. One consecutive year of lessons on the same instrument; one consecutive year in the same ensemble. Honors in music adds one advanced independent study to this list.

Music and Culture

Music 101 or 151, 131, 211; a total of five electives: two or three from the music department (including at least one at the 200 level); and two or three relevant and sequential courses from another department, including at least one at the 200 level; a 200-level independent