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The Curriculum

BOWDOIN DOES NOT PRESCRIBE specific liberal arts courses for all students. Instead, each student determines, with the help and approval of an academic advisor, an appropriate pattern of courses. The College also recognizes through its course offerings and requirements the importance of relating a liberal education to a world whose problems and needs are continually changing.

A vital part of this educational experience takes place in the interaction between students and their academic advisors. Each student is assigned an academic advisor at the start of the first year. Students generally maintain this relationship for the first two years. Whenever possible, the Dean's Office assigns advisors on the basis of students' intellectual interests and stated preference. Advisors and students first meet during new student orientation and regularly consult prior to each registration period.

Students must elect a major during the second semester of the sophomore year. After registering for a major, a student is advised by a member of his or her major department.

ACADEMIC REQUIREMENTS FOR THE DEGREE

To qualify for the bachelor of arts degree, a student must have

1. successfully passed 32 courses;
2. spent four semesters (passing at least 16 courses) in residence, at least two semesters of which will have been during the junior and senior years;
3. completed at least two semester courses in each of the following divisions of the curriculum—natural science and mathematics, social and behavioral sciences, and humanities and fine arts—and two semester courses in non-Eurocentric studies; and
4. completed a departmental major or majors, an interdisciplinary major, or a student-designed major (a departmental minor may be completed with any of the preceding).

No student will ordinarily be permitted to remain at Bowdoin for more than nine semesters of full-time work.

DISTRIBUTION REQUIREMENTS

Distribution requirements should normally be completed by the end of the sophomore year. Students must take two courses from each of the three divisions of the curriculum, with two courses in non-Eurocentric studies. A course that satisfies the non-Eurocentric studies requirement may also count for its division. Because these requirements are intended to apply to the college liberal arts experience, they may not be met by Advanced Placement or International Baccalaureate credits, but may be met, under the supervision of the Recording Committee, by credits earned while studying away from Bowdoin. Areas of distribution are defined as follows:

Natural Science and Mathematics: Biochemistry, biology, chemistry, computer science, geology, mathematics, neuroscience, physics, and certain environmental studies courses. (Designated by the letter ***a*** following a course number in the course descriptions.)

Social and Behavioral Sciences: Africana studies, economics, government, psychology, sociology and anthropology, and certain Asian studies, environmental studies, history, and women's studies courses. (Designated by the letter *b* following a course number in the course descriptions.)

Humanities and Fine Arts: Art, Chinese, classics, dance, education, English, film, German, Japanese, music, philosophy, religion, Romance languages, Russian, theater, most history courses, and certain Asian studies and women's studies courses. (Designated by the letter *c* following a course number in the course descriptions.)

Non-Eurocentric Studies: Students must take two courses that focus on a non-Eurocentric culture or society, exclusive of Europe and European Russia and their literary, artistic, musical, religious, and political traditions. The requirement is intended to introduce students to the variety of cultures and to open their minds to the different ways in which people perceive and cope with the challenges of life. Though courses primarily emphasizing North American and European topics will not count toward this requirement, courses focusing on African-American, Native American, or Latin American cultures will meet the requirement. ***Language courses do not meet this requirement.*** (Designated by the letter ***d*** following a course number in the course descriptions.)

THE MAJOR PROGRAM

Students may choose one of six basic patterns to satisfy the major requirement at Bowdoin: a departmental major, a double major, an interdisciplinary major, a coordinate major, a student-designed major, or any of the preceding with a departmental minor. Majors are offered in the following areas:

Africana Studies
Anthropology
Art History
Asian Studies
Biochemistry
Biology
Chemistry
Classics and Classics/Archaeology

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18c,d. Religion and Social Movements in Latin America. Spring 1996. Ms. Hutchison.

252c,d. Colonial Latin America. Fall 1995. Ms. Hutchison.

255c,d. Modern Latin America. Spring 1996. Ms. Hutchison.

256c,d. Comparative Slavery. Fall 1996. Mr. Wells.
(Same as **Africana Studies 256.**)

258c,d. Latin American Revolutions. Spring 1997. Mr. Wells.

350c,d. Gender and Social Transformation in Latin America. Fall 1995. Ms. Hutchison.

351c,d. The Mexican Revolution. Spring 1997. Mr. Wells.
Prerequisite: **History 252** or **255.**

355c,d. Economic Theory and the Problem of Underdevelopment in Latin America. Fall 1996. Mr. Wells.
Prerequisite: **History 252** or **255.**

Spanish

205c. Advanced Spoken and Written Spanish. Every fall. Ms. Jaffe.
Prerequisite: **Spanish 204** or placement.

313c,d. Indigenous and Hispanic Literature of Colonial Latin America. Spring 1996. Ms. Jaffe.
Prerequisite: **Spanish 209** or permission of the instructor.

Mathematics

Professors
William H. Barker
Stephen T. Fisk
Charles A. Grobe, Jr.
R. Wells Johnson, *Chair*
James E. Ward

Associate Professor
Rosemary A. Roberts†

Assistant Professors
Adam B. Levy
Helen E. Moore

Requirements for the Major in Mathematics

M

A major consists of at least eight courses numbered 200 or above, including at least one of the following—**Mathematics 262, 263, 286,** or a course numbered in the 300s.

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.

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All majors should take basic courses in algebra (e.g., **Mathematics 222** or **262**) and in analysis (e.g., **Mathematics 223** or **263**), and they are strongly encouraged to complete at least one sequence in a specific area of mathematics. Those areas are algebra (**Mathematics 222, 262,** and **302**); analysis (**Mathematics 243, 263,** and **303**); applied mathematics (**Mathematics 224, 264,** and **304**); probability and statistics (**Mathematics 225, 265,** and **305**); and geometry/topology (**Mathematics 247, 286,** and **287**). 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 which 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 above, at least one of which must be **Mathematics 243, 247,** or any mathematics course numbered 262 or above. For students who major in computer science and who therefore take **Mathematics 228, 231,** and **289,** the minor consists of a minimum of three additional courses numbered 200 or above, at least one of which must be **Mathematics 243, 247,** or any mathematics course numbered 262 or above.

Interdisciplinary Majors

The department participates in interdisciplinary programs in mathematics and economics and in computer science and mathematics. See page 134.

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

For secondary school teaching: **Computer Science 101, Mathematics 222, 225, 242, 247, 262, 263, 265, 288.**

For graduate study: **Mathematics 222, 223, 243, 262, 263, 286,** and at least one course numbered in the 300s.

For engineering and applied mathematics: **Mathematics 223, 224, 225, 243, 244, 264, 265, 288, 304.**

For mathematical economics and econometrics: **Mathematics 222, 223** or **263, 225, 244, 249, 265, 269, 288, 305,** and **Economics 316.**

For computer science: **Computer Science 220, 231; Mathematics 222, 225, 228, 244, 249, 262, 265, 288, 289.**

For operations research and management science: **Mathematics 222, 225, 249, 265, 269, 288, 305,** and **Economics 316.**

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C

[50a. Topics in Mathematics.]

60a. Introduction to College Mathematics. Every spring. THE DEPARTMENT.

Material selected from the following topics: combinatorics, probability, modern algebra, logic, linear programming, and computer programming. This course, followed by **Mathematics 75** 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.

75a. Introduction to Statistics and Data Analysis. Every spring. Spring 1996. MR. FISK.

Students learn to draw conclusions from data using exploratory data analysis and statistical techniques. Examples are drawn primarily from the life sciences. The course includes topics from exploratory data analysis, the planning and design of experiments, the analysis of normal measurements, and nonparametric inference. The computer is used extensively.

Open to students whose secondary school background has included at least three years of mathematics. Not open to students who have taken a college-level statistics course (such as **Psychology 250** or **Economics 257**).

161a. 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. Three hours of class meetings per week, plus a minimum of two hours of laboratory work every other week.

Open to students who have taken at least three years of mathematics in secondary school.

171a. 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. Three hours of class meetings per week, plus a minimum of two hours of laboratory work every other week.

Prerequisite: **Mathematics 161** or equivalent.

172a. Integral Calculus, Advanced Section. Every fall. Fall 1995. MR. BARKER.

A review of numerical integration and techniques of integration. Improper integrals. Approximations using Taylor polynomials and infinite series. Emphasis on differential equation models and their solutions. Four and a half hours of class meetings and computer laboratory sessions per week.

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.

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181a. 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 and a half hours of class meetings and computer laboratory work sessions per week.

Prerequisite: **Mathematics 171** or equivalent.

222a. Linear Algebra. Every spring. Spring 1996.

Topics include vectors, matrices, determinants, vector spaces, inner product spaces, linear transformations, eigenvalues and eigenvectors, and quadratic forms. Applications to linear equations, conics, quadric surfaces, least-squares approximation, and Fourier series.

Prerequisite: **Mathematics 181** or permission of the instructor.

223a. Vector Calculus. Every fall. Fall 1995. MR. JOHNSON.

The basic concepts of multivariate and vector calculus. Topics include continuity; the derivative as best affine approximation; the chain rule; Taylor's theorem and applications to optimization; Lagrange multipliers; linear transformations and Jacobians; multiple integration and change of variables; line and surface integration; gradient, divergence, and curl; conservative vector fields; and integral theorems of Green, Gauss, and Stokes. Applications from economics and the physical sciences are discussed as time permits.

Prerequisite: **Mathematics 181.**

224a. Applied Mathematics I. Every other fall. Fall 1996. MR. LEVY.

An introduction to the theory of ordinary differential equations with diverse applications to problems arising in the natural and social sciences. Emphasis on the rigorous development of the different methods of solution. Topics include first-, second- and higher-order equations with applications in qualitative stability and oscillation theory, Laplace transforms, series solutions, and the existence and uniqueness theorems. A few numerical methods are introduced sporadically during the course.

Prerequisite: **Mathematics 171.**

225a. Probability. Every fall. Fall 1995. MR. BARKER.

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.**

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228a. Discrete Mathematical Structures. Every spring.

An introduction to logic, reasoning, and the discrete mathematical structures that are important in computer science. Topics include propositional logic, types of proof, induction and recursion, sets, counting, functions, relations, and graphs.

Prerequisite: **Mathematics 161** or permission of the instructor.

231a. Algorithms. Every fall. Fall 1995. Mr. Garnick.

The study of algorithms concerns programming for computational efficiency, as well as problem-solving techniques. The course covers practical algorithms and theoretical issues in the design and analysis of algorithms. Topics include trees, graphs, sorting, dynamic programming, NP-completeness, and approximation algorithms. Laboratory experiments are used to illustrate principles. (Same as **Computer Science 231.**)

Prerequisites: **Computer Science 210** and **Mathematics 228,** or permission of the instructor.

242a. Number Theory. Every other fall. Fall 1996.

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.

243a. Functions of a Complex Variable. Every other spring. Spring 1996. Mr. Barker.

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 171.**

244a. Numerical Methods. Every other spring. Spring 1996. Mr. Levy.

An introduction to the numerical solutions of mathematical problems. Topics include methods for solving linear systems, approximation theory, numerical differentiation and integration, and numerical methods for differential equations. Whenever possible, numerical techniques are used to solve mathematical problems generated by applied physical examples. Students are required to develop computer programs for the topics covered; additional instructional time may be scheduled for computer laboratory demonstrations.

Prerequisites: **Mathematics 181** or **222.**

247a. Geometry. Every other fall. Fall 1995. Ms. Moore.

A survey of classical Euclidean and non-Euclidean geometry. Neutral geometry: the common ground of both Euclidean and non-Euclidean geometry. Parallel postulates. Hyperbolic and elliptic geometry.

Prerequisite: **Mathematics 181** or permission of the instructor.

249a. Linear Programming and Optimization. Every other fall. Fall 1996.

A survey of some of the mathematical techniques for optimizing various quantities, many of which arise naturally in economics and, more generally, in competitive situations. Production problems, resource allocation problems, transportation problems, and the theory of network flows. Game theory and strategies for matrix games. Emphasis on convex and linear programming methods, but other nonlinear optimization techniques are presented. Includes computer demonstrations of many of the techniques that are discussed.

Prerequisite: Mathematics 181.

255a. Applied Multivariate Statistics. Every other fall. Fall 1995. Mr. Fisk.

An introduction to the techniques of applied multivariate analysis based on matrix algebra and the multivariate normal distribution. Topics to be discussed include discriminant analysis, principal components, factor analysis, canonical correlation, multidimensional scaling, classification, and graphical techniques. Students learn how to run and interpret the output from the statistical package Splus.

Prerequisites: **Mathematics 181** and a college-level statistics course.

262a. Introduction to Algebraic Structures. Every other fall. Fall 1995. Mr. Ward.

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 222,** or **Mathematics 181** and permission of the instructor.

263a. Introduction to Analysis. Every other fall. Fall 1996.

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 171.**

264a. Applied Mathematics II. Every other spring. Spring 1997. Mr. Levy.

A continuation of **Mathematics 224** and an introduction to dynamical systems. Topics include series solutions and special functions, the applica-

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tions of linear algebra and vector analysis to the solutions of systems of first-order linear differential equations, stability of linear systems, Green's functions and inhomogeneous equations, and nonlinear equations, with emphasis on stability of equilibria, perturbation theory, chaos theory, and a few numerical methods.

Prerequisite: **Mathematics 224,** or permission of the instructor.

265a. Statistics. Every spring. Spring 1996. Mr. Fisk.

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.

Prerequisites: **Mathematics 225.**

269a. Seminar in Operations Research and Mathematical Models. Every other spring. Spring 1997.

Selected topics in operations research and some of the mathematical models used in economics. Emphasis is on probabilistic models and stochastic processes, with applications to decision analysis, inventory theory, forecasting, and queueing theory.

Prerequisites: **Mathematics 225** and **249,** or permission of the instructor.

[286a. Topology.]

287a. Advanced Topics in Geometry. Every other spring. Spring 1996. Ms. Moore.

One or more selected topics from classical geometry, projective geometry, algebraic geometry, or differential geometry.

Prerequisite: **Mathematics 247.**

288a. Combinatorics and Graph Theory. Every other spring. Spring 1997.

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 228** or **262** or **263** or permission of the instructor.

289a. Theory of Computation. Every spring. Spring 1996. Mr. Ramshaw. (Same as **Computer Science 289.**)

Prerequisite: **Mathematics 228** or permission of the instructor.

302a. Advanced Topics in Algebra. Every other spring. Spring 1996. Mr. Ward.

One or more specialized topics from abstract algebra and its applications. Topics may include group representation theory, coding theory, symmetries, ring theory, finite fields and field theory, algebraic numbers, and Diophantine equations.

Prerequisite: **Mathematics 262.**

303a. Advanced Topics in Analysis. Every other spring. Spring 1997.

One or more selected topics from analysis. Topics may be chosen from Lebesgue integration, general measure and integration theory, Fourier analysis, Hilbert and Banach space theory, and spectral theory.

Prerequisite: **Mathematics 263.**

304a. Advanced Topics in Applied Mathematics. Every other fall. Fall 1997. Mr. Levy.

One or more selected topics in applied mathematics. Material selected from the following: Fourier series, partial differential equations, integral equations, calculus of variations, bifurcation theory, asymptotic analysis, applied functional analysis, and topics in mathematical physics.

Prerequisite: **Mathematics 264,** or permission of the instructor.

305a. Advanced Topics in Probability and Statistics. Every other fall. Fall 1996. Mrs. Roberts.

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.

Prerequisites: **Mathematics 222** and **265** or permission of the instructor.

291a–294a. Intermediate Independent Study. The Department.

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

Music

Professor
Elliott S. Schwartz

Associate Professors
Robert K. Greenlee, *Chair*
James W. McCalla

Visiting Assistant Professor
Liane R. Curtis

Director of the Bowdoin Chorus
Anthony F. Antolini

Director of the Bowdoin Orchestra
Paul Ross

Director of Concert Band
John Morneau

Adjunct Instructor
Frank X. Mauceri

Requirements for the Major in Music

The major in music consists of **Music 101** or exemption, **200, 203, 303, 304; Music 301, 302**; one topics course (either **Music 351, 352** or **361, 362**); one year of individual performance studies; one year of ensemble performance studies; and one elective course in music.