Bryn Mawr 2004-05

The Academic Program

The Bryn Mawr curriculum is designed to encourage breadth of learning and training in the fundamentals of scholarship in the first two years, and mature and sophisticated study in depth in a major program during the last two years. Its overall purpose is to challenge the student and prepare her for the lifelong pleasure and responsibility of educating herself and playing a responsible role in contemporary society. The curriculum encourages independence within a rigorous but flexible framework of divisional and major requirements and fosters self-recognition for individuals as members of diverse communities and constituencies.

The Bryn Mawr curriculum obtains further breadth through interinstitutional cooperation. Virtually all undergraduate courses and all major programs at Bryn Mawr and Haverford Colleges are open to students from both schools, greatly increasing the range of available subjects. With certain restrictions, full-time Bryn Mawr students may also take courses at Swarthmore College, the University of Pennsylvania and Villanova University during the academic year without payment of additional fees.

The Curriculum

Requirements for the A.B. Degree

For students who matriculated in the fall of 1998 or thereafter.

Students who matriculated with the classes of 1995-2001 from the fall of 1991 to January 1998 should consult the Requirements for the A.B. Degree on pages 52-54 of the Undergraduate College Catalog and Calendar 2000-01.

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Thirty-two units of work are required for the A.B. degree. These must include:

- Two units of College Seminars (one unit for the class of 2008).
- One course to meet the quantitative skills requirement.
- Work to demonstrate the required level of proficiency in foreign language.
- Six units to meet the divisional requirements.
- A major subject sequence.
- Elective units of work to complete an undergraduate program.

In addition, all students must complete eight half-semesters of physical education, successfully complete a swim proficiency test and meet the residency requirement.

College Seminars Requirement

The aim of the College Seminars is to engage students in careful examination of fundamental issues and debates that can illustrate the choices we make in our daily lives. By encouraging critical thinking, focused discussion and cogent writing, the seminars help prepare students for a modern world that demands perceptive understanding both within and outside of the frameworks of particular disciplines.

Each student must include in her program two units of College Seminars, the first to be taken in the first semester of the freshman year and the second before the end of the sophomore year. (Students in the class of 2008 must complete only one college seminar, to be taken in the fall of the freshman year.) Students must attain a grade of 2.0 or higher in each seminar used to satisfy this requirement.

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Foreign La Requirem

Bryn Mawr recognizes the inherent intellectual value and fundamental societal importance of acquiring a level of proficiency in the use of one or more foreign languages. The study of foreign languages serves a number of convergent curricular and student interests, including the appreciation of cultural differences, a global perspective across academic disciplines, cognitive insights into the workings of language systems, and alternative models of perceiving and processing human experience.

Before the start of the senior year, each student must have demonstrated a knowledge of one foreign language by:

- Passing a proficiency test offered by the College every spring and fall or
- Attaining a score of at least 690 in a language achievement test of the College Entrance Examination Board, or by passing with an honor grade an Advanced Placement, IB or A-level test or
- Completing at the College two courses (two units) above the elementary level with an average grade of at least 2.0 or a grade of at least 2.0 in the second course or
- For a non-native speaker of English who has demonstrated proficiency in her native language, two semesters of College Seminars or one College Seminar and one writing intensive course.

Quantitati Requireme

Before the start of the senior year, each student must have demonstrated competence in college-level mathematics or quantitative skills by:

- Passing with an honor grade an Advanced Placement, IB or A-level examination in mathematics or
- Passing one course with a grade of at least 2.0 from those designated with a "Q" in the Course Guide.

For students in the classes of 2002-2005, the course or examination used to fulfill the quantitative requirement may not also be counted toward any other requirement. For students who matriculate in the fall of 2002 or thereafter, a course used to fulfill the quantitative requirement may also be counted toward divisional requirements, so long as that course is identified as Q and Division I, II or III in the Course Guide.

Seminar in Phonology
Seminar in Psycholinguistics
Seminar in Semantics
Seminar in Syntax
Structure of Juvan
Structure of Navajo
Structure of American Sign Language
Syntax
Translation Workshop
Writing Systems, Decipherment and Cryptography

Mathematics

Professors:
Victor J. Donnay (on leave, 2004-05)
Helen G. Grundman, *Chair*
Rhonda J. Hughes (on leave, semester II)
Paul M. Melvin

Professor Emeritus:
Frederic Cunningham Jr.

Associate Professor:
Lisa Traynor

Assistant Professor:
Leslie C. Cheng

Instructors:
Mary Louise Cookson
(on leave, semester II)
Peter G. Kasius

Visiting Professor:
Yibiao Pan (semester II)

Visiting Associate Professor:
Walter Stromquist

The mathematics curriculum is designed to expose students to a wide spectrum of ideas in modern mathematics, train students in the art of logical reasoning and clear expression, and provide students with an appreciation of the beauty of the subject and of its vast applicability.

Major Requirements

A minimum of 10 semester courses are required for the major, including the six core courses listed below and four electives at or above the 200 level.

Core Requirements:
Multivariable Calculus (201; H121)
Linear Algebra (203; H215)
Real Analysis (301/302; H317/318)
Abstract Algebra (303; H333)
Senior Conference (398 or 399)

With the exception of Senior Conference, equivalent courses at Haverford or elsewhere may be substituted for Bryn Mawr courses. In consultation with a major adviser, a student may also petition the department to accept courses in fields outside of mathematics as electives if these courses have serious mathematical content appropriate to the student's program.

Math majors are encouraged to complete their core requirements other than Senior Conference by the end of their junior year. Senior Conference must be taken during the senior year. Students considering the possibility of graduate study in mathematics or related fields are urged to go well beyond the minimum requirements of the major. In such cases, a suitable program of study should be designed with the advice of a major adviser.

Honors

A degree with honors in mathematics will be awarded by the department to students who complete the major in mathematics and also meet the following further requirements: at least two additional semesters of work at the 300 level or above (this includes Supervised Work 403), completion of a meritorious project consisting of a written thesis and an oral presentation of the thesis, and a major grade point average of at least 3.6, calculated at the end of the senior year.

Minor Requirements

The minor requires five courses in mathematics at the 200 level or higher, of which at least two must be at the 300 level or higher.

Advanced Placement

Students entering with a 4 or 5 on the Calculus AB advanced placement test will be given credit for Math 101 and should enroll in Math 102 as their first mathematics course. Students entering with a 4 or 5 on the Calculus BC advanced placement test will be given credit for Math 101 and 102, and should enroll in Math 201 as their first mathematics course. All other students are strongly encouraged to take the Mathematics Placement Exam so they can be best advised.

A.B./M.A. Program

For students entering with advanced placement credits it is possible to earn both the A.B. and M.A. degrees in an integrated program in four or five years.

See also page 19 for a description of the 3-2 Program in Engineering and Applied Science, offered in cooperation with the California Institute of Technology, for earning both an A.B. at Bryn Mawr and a B.S. at Cal Tech.

Suggested Electives

Below are some general guidelines for the selection of electives for students who wish to pursue a program focused in either pure or applied mathematics.

Pure Mathematics Focus
Strongly recommended:
Transition to Higher Mathematics (206)
Differential Equations with Applications (210; H204)
Abstract Algebra, semester II (304; H334)
Topology (312; H335)
Functions of Complex Variables (322)

Select additional courses from:
Introduction to Topology and Geometry (221)
Partial Differential Equations (311)
Topology, semester II (313; H336)
Functions of Complex Variables, semester II (323)
Number Theory (290, 390)
Chaotic Dynamical Systems (351)

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Applied Mathematics Focus

Strongly recommended:

Theory of Probability with Applications (205; H218)

Differential Equations with Applications (210; H204)

Partial Differential Equations (311)

Select additional courses from:

Statistical Methods and Their Applications (H203)

Linear Optimization and Game Theory (H210)

Discrete Mathematics (231)

Applied Mathematics (308)

Functions of Complex Variables (322)

Chaotic Dynamical Systems (351)

Students interested in pursuing graduate study or careers in economics, business or finance should consider taking 205, 210, 225, 310 and 311, and at least one of 308, H203 or H210. Also strongly recommended is Introduction to Computer Science (Computer Science 110), even though it would not count toward the mathematics major. These students might also consider a minor in economics and should consult the economics department chair as early as possible, ideally during the spring of sophomore year.

For students who wish to pursue a more computational major, the Discrete Mathematics course (231) is highly recommended. In addition, certain computer science courses will be accepted as electives, including Analysis of Algorithms (H340), Theory of Computation (H345), and Advanced Topics in Discrete Mathematics and Computer Science (H394). These courses may count toward a computer science minor as well; see the Computer Science listings on page 131.

Students in the Calculus sequence need a grade of 2.0 or better to continue with the next course.

001. Fundamentals of Mathematics
Basic techniques of algebra, analytic geometry, graphing and trigonometry for students who need to improve these skills before entering other courses that use them, both inside and outside mathematics. Placement in this course is by advice of the department and permission of the instructor. (staff)

101, 102. Calculus with Analytic Geometry
Differentiation and integration of algebraic and elementary transcendental functions, with the necessary elements of analytic geometry and trigonometry; the fundamental theorem, its role in theory and applications, methods of integration, applications of the definite integral, infinite series. May include a computer lab component. Prerequisite: math readiness or permission of the instructor. (staff, Division II or Quantitative Skills)

104. Elements of Probability and Statistics
Basic concepts and applications of probability theory and statistics, including finite sample spaces, permutations and combinations, random variables, expected value, variance, conditional probability, hypothesis testing, linear regression and correlation. The computer is used; prior knowledge of a computer language is not required. This course may not be taken after any other statistics course. Prerequisite: math readiness or permission of instructor. (staff, Quantitative Skills)

201. Multivariable Calculus
Vectors and geometry in two and three dimensions, partial derivatives, extremal problems, double and triple integrals, line and surface integrals, Green's and Stokes' Theorems. May include a computer lab component. Prerequisite: Mathematics 102 or permission of instructor. (staff, Division II or Quantitative Skills)

203. Linear Algebra
Matrices and systems of linear equations, vector spaces and linear transformations, determinants, eigenvalues and eigenvectors, inner product spaces and quadratic forms. May include a computer lab component. Prerequisite: Mathematics 102 or permission of instructor. (staff, Division II or Quantitative Skills)

205. Theory of Probability with Applications
Random variables, probability distributions on Rn, limit theorems, random processes. Prerequisite: Mathematics 201. (staff, Division II or Quantitative Skills) *Not offered in 2004-05.*

206. Transition to Higher Mathematics
An introduction to higher mathematics with a focus on proof writing. Topics include active reading of mathematics, constructing appropriate examples, problem solving, logical reasoning and communication of mathematics through proofs. Students will develop skills while exploring key concepts from algebra, analysis, topology and other advanced fields. Corequisite: Mathematics 203; not open to students who have had a 300-level math course. (Traynor, Division II)

210. Differential Equations with Applications
Ordinary differential equations, including general first-order equations, linear equations of higher order and systems of equations, via numerical, geometrical and analytic methods. Applications to physics, biology and economics. Corequisite: Math 201 or Math 203. (Pan, Division II or Quantitative Skills)

221. Introduction to Topology and Geometry
An introduction to the ideas of topology and geometry through the study of knots and surfaces in 3-dimensional space. The course content may vary from year to year, but will generally include some historical perspectives and some discussion of connections with the natural and life sciences. Corequisite: Mathematics 201 or 203. (staff, Division II) *Not in offered 2004-05.*

225. Introduction to Financial Mathematics
Topics to be covered include market conventions and instruments, Black-Scholes option-pricing model, and practical aspects of trading and hedging. All necessary definitions from probability theory (random variables, normal and lognormal distribution, etc.) will be explained. Prerequisite: Mathematics 102. Economics 105 is recommended. (Stromquist, Division II)

231. Discrete Mathematics
An introduction to discrete mathematics with strong applications to computer science. Topics include set theory, functions and relations, propositional logic, proof techniques, recursion, counting techniques, difference equations, graphs and trees. (Weaver, Division II or Quantitative Skills; cross-listed as Computer Science 231 and Philosophy 230)

251. Introduction to Chaotic Dynamical Systems
Topics to be covered may include iteration, orbits, graphical and computer analysis, bifurcations, symbolic dynamics, fractals, complex dynamics and applications. Prerequisite: Mathematics 102. (staff, Division II or Quantitative Skills) *Not offered in 2004-05.*

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290. Elementary Number Theory
Properties of the integers, divisibility, primality and factorization, congruences, Chinese remainder theorem, multiplicative functions, quadratic residues and quadratic reciprocity, continued fractions, and applications to computer science and cryptography. Prerequisite: Mathematics 102. (staff, Division II or Quantitative Skills) *Not offered in 2004-05.*

295. Selected Topics in Mathematics
This course will cover topics that are not part of the standard departmental offerings and will vary from semester to semester. Students may take this course more than once. Spring 2005: Elementary Complex Analysis. Prerequisite: Math 201. (Pan, Division II)

301, 302. Introduction to Real Analysis
The real number system, elements of set theory and topology, continuous functions, uniform convergence, the Riemann integral, power series, Fourier series and other limit processes. Prerequisite: Mathematics 201. (Hughes, Pan, Traynor, Division II)

303, 304. Abstract Algebra
Groups, rings, fields and their morphisms. Prerequisite: Mathematics 203. (Cheng, Grundman, Division II)

311. Partial Differential Equations
Heat and wave equations on bounded and unbounded domains, Laplace's equation, Fourier series and the Fourier transform, qualitative behavior of solutions, computational methods. Applications to the physical and life sciences. Prerequisite: Mathematics 301 or permission of instructor. (Cheng, Division II)

312, 313. Topology
General topology (topological spaces, con-tinuity, compactness, connectedness, quotient spaces), the fundamental group and covering spaces. Introduction to geometric topology (classification of surfaces, manifolds) and algebraic topology (homotopy theory, homology and cohomology theory, duality on manifolds). Prerequisites: Mathematics 201 and 203, or permission of instructor. (Melvin, Division II)

315. Geometry
An introduction to geometry with an emphasis that varies from year to year. For fall 2003, the topic will be differential geometry, where local and global properties of parameterized curves and surfaces will be studied. Prerequisites: Mathematics 201 and 203 (or equivalent) or permission of instructor. (staff, Division II) *Not offered in 2004-05.*

322, 323. Functions of Complex Variables
Analytic functions, Cauchy's theorem, Laurent series, calculus of residues, conformal mappings, Moebius transformations, infinite products, entire functions, Riemann mapping theorem, Picard's theorem. Prerequisite: Mathematics 301 or permission of instructor. (staff, Division II) *Not offered in 2004-05.*

361. Introduction to Harmonic Analysis and Wavelets
A first introduction to harmonic analysis and wavelets. Topics to be covered include Fourier series on the circle, Fourier transforms on the line and space, Discrete Wavelet Transform, Fast Wavelet Transform and filter-bank representation of wavelets. Prerequisite: Mathematics 203 or permission of instructor. (staff, Division II) *Not offered in 2004-05.*

390. Number Theory
Algebraic number fields and rings of integers, quadratic and cyclotomic fields, norm and trace, ideal theory, factorization and prime decomposition, lattices and the geometry of algebraic integers, class numbers and ideal class groups, computational methods, Dirichlet's unit theorem. Prerequisite: Mathematics 303 or permission of instructor. (Grundman, Division II)

395, 396. Research Seminar
A research seminar for students involved in individual or small group research under the supervision of the instructor. With permission, the course may be repeated for credit. Prerequisite: Mathematics 203 or permission of instructor. (staff, Division II)

398, 399. Senior Conference
A seminar for seniors majoring in mathematics. Topics vary from year to year. (Cunningham, Stromquist, Division II)

403. Supervised Work (staff)

Haverford College currently offers the following courses in mathematics:

103. Introduction to Probability and Statistics
104. Calculus: Concepts and History
113. Calculus I
114. Introductory Integral Calculus
115. Calculus Applications: Series, Parametric Curves and Complex Numbers
116. Calculus Applications: Probability Distributions
117. Calculus Applications: Multivariable Optimization
121. Calculus III
203. Statistical Methods and Their Applications
204. Differential Equations
205. Topics in Geometry
215. Linear Algebra
216. Advanced Calculus
218. Probability
235. Information and Coding Theory
317. Analysis I
318. Analysis II
333. Algebra I
334. Algebra II
335. Topology I
336. Topology II
340. Analysis of Algorithms
390. Advanced Topics in Algebra
391. Advanced Topics in Geometry and Topology
395. Advanced Topics in Cominatorics
397. Advanced Topics in Applied Mathematics
399. Senior Seminar