Bryn Mawr 1994-5

CURRICULUM

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. It 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 inter-institutional 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. 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 degree of Bachelor of Arts is conferred upon students who have completed the requirements described below.

REQUIREMENTS FOR THE A.B. DEGREE

Summary of Requirements
For students who matriculated in September, 1991, or thereafter. Students who matriculated prior to September, 1991 should consult the 1990-91 Undergraduate Catalogue for applicable degree requirements.

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

1. two courses (one for students with advanced placement) in English composition, unless exempt
2. one course to meet the quantitative skills requirement
3. work to demonstrate the required level of proficiency in foreign language
4. eight units to meet the divisional requirements
5. a major subject sequence
6. elective units of work to complete an undergraduate program.

In addition, all students must complete eight half semesters of physical education and must meet the residency requirement.

English Composition Requirement
Each student must include in her program two semesters of English composition (English 015-016) to be taken during her freshman year, unless she has achieved a score of 5 on the Advanced Placement Test or an equivalent. Such students must take one semester of composition. The English department also administers an exemption test upon request at the beginning of each academic year.

Quantitative Requirement
Each student must complete work in college-level mathematics or quantitative skills to consist of:

a. passing with an honor grade an Advanced Placement examination in mathematics, or

b. passing one course (one unit) in mathematics at the 100 level or above, or

c. passing one course from among those designated with a "Q" in the Course Guide, or

d. passing one math course which has 100-level math as a prerequisite, in which case the prerequisite will satisfy the quantitative skills.

For students who matriculate in and after September 1991, courses used to fulfill the requirement in Quantitative Skills may also be counted in Division II if they are identified as both Division II and Quantitative Skills in the course guide.

Foreign Language Requirement
There are two parts to this requirement:
1. Competence in Language: A knowledge of one language other than English (or other than the student's language of origin) to be demonstrated by:

a. passing a proficiency test offered by the College every spring and fall, or

b. attaining a score of at least 650 in a language achievement test of the College Entrance Examination Board (CEEB), or by passing with an honor grade an Advanced Placement test, also offered by CEEB, in French, German, Spanish, or Latin. (The number of academic units of credit awarded for honor grades in Advanced Placement exams is determined by the departments), or

c. completing two courses (two units) at the College 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.

2. Additional Work in Language or Mathematics: to consist of:

a. completing a foreign language to an advanced level, defined as passing two courses (two units) at the 200 level or above with an average grade of at least 2.0 or a grade of 2.0 in the second course, or passing a proficiency test, the nature and standard of which are determined by the departments of foreign languages with the approval of the Curriculum Committee, or

b. attaining knowledge of a second foreign language to be demonstrated in the same way as knowledge of the first (1c. above), or

c. completing two courses (two units) in mathematics at the 100 level

or above, including at least one semester of calculus.
d. passing with at least a grade of 2.0 a course in mathematics which has a 100-level math course as a prerequisite. Either the course taken or the prerequisite must be in calculus.

Courses used to fulfill the additional work requirement in mathematics cannot also be counted toward divisional requirements. Courses taken to fulfill additional work in language, if they otherwise carry divisional credit, may be counted toward divisional requirements.

Foreign Language Requirement for Non-Native Speakers of English
Students whose language of origin is not English are those who applied to Bryn Mawr as international students and indicated on their admission application that English is not their language of origin, who have had several years of school in a language other than English and who are able to read, write, and speak this language, or who have submitted TOEFL scores as part of their admission application.

For these students two semesters of English 015, 016: Reading and Composition fulfills the requirement for competence in language (as well as the English composition requirement). Non-native speakers of English who wish to complete the requirement for additional work by completing foreign language to an advanced level must pass two courses (two units) offered by the English department at the 200 level or higher, with an average grade of at least 2.0 or a grade of 2.0 in the second course.

Divisional Requirements
Each student must complete two units in the social sciences (Division I), three units in the natural sciences and mathematics (Division II), and three units in the humanities (Division III). At least two units in Division II must be laboratory science courses, and at least two different disciplines in Division II must be represented in the total of three units. Division III includes the performing and studio arts as well as courses in the history, theory, or criticism of the arts. One unit of performance or studio art may be counted toward the requirement in Division III. Students majoring in the humanities must offer at least one unit outside their major in Division III to fulfill the requirement.

Students should have made substantial progress on their divisional requirements before the start of the senior year. The requirement for laboratory work must be fulfilled before the start of the senior year. No course may satisfy more than one divisional requirement. A student may not use courses in her major subject to satisfy more than one divisional requirement, unless the courses are cross listed in other departments. English 015 and 016 do not meet the divisional requirement in Division III.

Divisional credit is assigned by course. Students should consult the course guide published each semester to inform themselves of which courses satisfy the various divisional requirements. Each student is responsible for understanding what divisional credit she may earn for the courses she takes. The Curriculum Committee considers petitions from individual students for exceptions.

Students who matriculated before September, 1987, should consult earlier editions of the Bryn Mawr College Catalogue for the divisional requirement that applies to them.

1994-95

104. The City of Rome in Latin Literature from Augustus to Charlemagne (Scott, Division III) *Not offered in 1994-95.*

201. Advanced Latin Literature: Augustan Poetry Selections from Vergil's *Eclogues*, Horace, and the elegists. (James, Division III) *Not offered in 1994-95.*

202. Advanced Latin Literature: The Silver Age Readings from major authors of the first and second centuries A.D. *Taught as Classics 252b at Haverford.* (staff, Division III)

203. Medieval Latin Literature Selected works of Latin prose and poetry from the late Roman Empire through the Carolingian Renaissance. (Scott, Division III)

205. Latin Style A study of Latin prose style and Latin metrics based on readings and exercises in composition. (staff) *Offered on demand to students wishing to fulfill the requirements for teacher certification in Latin or to fulfill one of the requirements in the major.*

207. Roman History A study of Rome from its origins to the end of the Republic with special emphasis on the rise of Rome in Italy, the Hellenistic world, and the evolution of the Roman state. Ancient sources, literary and archaeological, are emphasized. (Scott, Division III; cross listed as History 207) *Alternates with Latin 208.*

208. The Roman Empire Imperial history from the principate of Augustus to the House of Constantine with focus on the evolution of Roman culture as presented in the surviving ancient evidence, literary and archaeological. (Scott, Division III; cross listed as History 208) *Alternates with Latin 207; not offered in 1994-95.*

301. Vergil's Aeneid (James, Division III)

302. Tacitus (Scott, Division III) *Not offered in 1994-95.*

303. Lucretius Study of the *De Rerum Natura* and its philosophic background. (staff, Division III) *Not offered in 1994-95.*

304. Cicero and Caesar (staff, Division III) *Not offered in 1994-95.*

305. Livy and the Conquest of the Mediterranean (Scott, Division III; cross listed as History 305)

310. Catullus and the Elegists (staff, Division III) *Not offered in 1994-95.*

324. Roman Architecture (Scott, Division III; cross listed as Archaeology 324)

398, 399. Senior Conference Topics in Latin literature. (staff)

The following courses are also of interest to Latin majors:

Classical and Near Eastern Archaeology 324. Roman Architecture

Comparative Literature 170. The Classical Hero(ine)
Comparative Literature 247. Women and Conflict from Antiquity to the Present
General Studies 152. Self, Symbol, and Society in Classical Epic
General Studies 153. Roman Women

Haverford College offers the following courses in Latin:

Classics 002. Elementary Latin
Classics 102a, b. Introduction to Latin Literature
Classics 252a, b. Advanced Latin

MATHEMATICS

Professors:
Frederic Cunningham, Jr., Ph.D., *Katharine E. McBride Professor Emeritus of Mathematics*
Rhonda J. Hughes, Ph.D., *Helen Herrmann Professor of Mathematics*
Paul Melvin, Ph.D., *Chairman*

Assistant Professors:
Danielle Carr, Ph.D. (on leave, Semester I, 1994-95)
Victor Donnay, Ph.D.
Helen Grundman, Ph.D., *on the Rosalyn R. Schwartz Lectureship* (on leave, 1994-95)
Lisa Traynor, Ph.D. (on leave, Semester I, 1994-95)

Instructors:
Mary Louise Cookson, M.A., *Senior Program Coordinator* (on leave, Semester II, 1994-95)
Peter G. Kasius, M.A.
Lisa Sigler, M.A.

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The mathematics major requires six core courses and four elective courses at or above the 200 level. Students interested in graduate school in mathematics should take more than the minimum number of courses required. Any of this work other than Senior Conference may be taken at Haverford or elsewhere.

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

You may complete the major with any four mathematics courses at or above the 200 level, but if you wish to pursue a more focused program, we offer various options:

(I) *Pure Mathematics Option*
Strongly recommended for graduate school:
Vector Calculus (202; H216)

Abstract Algebra, semester II (304; H334)
Topology (312; H335)
Complex Variables (322)
Select additional courses from:
Differential Equations (210; H204)
Topology, semester II (313; H336)
Partial Differential Equations (311)
Complex Variables, semester II (323)
Chaotic Dynamical Systems (351)

(II) *Applied Mathematics Option*
Select remaining courses from:
Vector Calculus (202; H216)
Differential Equations (210; H204)
Probability/Statistics (205; H218)
Discrete Mathematics (231; H190)
Partial Differential Equations (311)
Complex Variables (322)
Mathematical Biology (329)
Chaotic Dynamical Systems (351)
Numerical Analysis (H320)

(III) *Computational Mathematics Option*
In addition to the six core courses, the following courses are required:
Introduction to Computing (CS110; H105)
Data Structures and Algorithms (CS206)
Discrete Mathematics (231)
Plus any two courses selected from:
Principles of Computer Organization (H240)
Principles of Programming Language (H245)
Programming Paradigms (CS246)
Analysis of Algorithms (H340)
Theory of Computation (H345)
Introduction to Artificial Intelligence (CS372)

(IV) *Mathematical Physics Major*
The Departments of Mathematics and Physics offer a joint independent major in mathematical physics supervised by Professor Albano (physics) and Professor Hughes (mathematics). Students interested in this program are encouraged to consult either one of these two faculty members.

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 64 for a description of the five-year joint program with the University of Pennsylvania for earning both an A.B. at Bryn Mawr and an engineering degree at Penn.

The degree with honors in mathematics is awarded by the department to students who have achieved excellence in the work of the major and in a program of independent work undertaken in the senior year, including an honors thesis, which may be an expository paper or some original research.

Requirements for the minor in mathematics are six courses in mathematics at the 100 level or higher, of which at least four are 200 level or higher, and at least two are 300 level or higher. Math AP credits with a score of 4 or 5 may be counted toward the minor in mathematics.

Any course in mathematics at the 100 level or above satisfies the College requirement of work in mathematics or Quantitative Skills. Moreover, students who choose to fulfill the additional work requirement in mathematics, rather than language, must take a semester of calculus and any other semester course in mathematics at the 100 level or above. Consult the curriculum section of this catalogue for further information.

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 which use them, both inside and outside mathematics. Placement in this course is by advice of the department and consent of 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. Prerequisite: Math readiness or permission of instructor. (staff, Division II, Quantitative Skills)

103. Matrices and Linear Programming Matrices, linear equations, and inequalities; linear programming problems, with applications; the simplex algorithm; duality and two-person matrix games. Elementary computer programming is included so that non-trivial problems can be solved numerically. Other uses of matrices as time permits, such as Markov chains, or incidence matrices of graphs. Prerequisite: Math readiness or permission of instructor. (staff, Division II, 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. If a student plans to take this course, it should be taken before any statistics course offered by the social sciences. Prerequisite: Math readiness or permission of instructor. (staff, Division II, Quantitative Skills)

107. Experiments in Dynamical Systems Computational experiments in the behavior of functions under iteration, using computer graphics. Discussion of examples of dynamical systems as models of natural phenomena. Stable orbits and convergence to equilibrium; periodicity; fractal attractors; bifurcations and chaos. Students should have some literacy in basic mathematical notations such as functions, variables, and exponents. (staff, Division IIL, Quantitative Skills) *Not offered in 1994-95.*

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. Prerequisite: Mathematics 102 or permission of instructor. (staff, Division II, Quantitative Skills)

202. Vector Calculus Calculus in R^n, the total differential, implicit and inverse function theorems, multiple integrals, integration on manifolds, Green's and Stokes' Theorems. Prerequisite: Mathematics 201. (staff, Division II, 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. Prerequisite: Mathematics 102 or permission of instructor. Meets Division II requirement. (staff, Division II, Quantitative Skills)

205. Theory of Probability with Applications Random variables, probability distributions on R^n, limit theorems, random processes. Prerequisite: Mathematics 201. (staff, Division II, Quantitative Skills) *Not offered in 1994-95.*

210. Differential Equations with Applications Ordinary differential equations, including general first order equations, linear equations of higher order, series solutions, Laplace transforms, systems of equations and numerical methods. Introduction to Fourier series and partial differential equations. Applications to physics, biology and economics. Prerequisite: Mathematics 201. (staff, Division II, Quantitative Skills)

231. Discrete Mathematics An introduction to several topics in 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. (staff, Division II or Quantitative Skills; cross listed as Computer Science 231)

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. (Cunningham)

303, 304. Abstract Algebra Groups, rings, fields, and their morphisms. Prerequisite: Mathematics 203. (Melvin)

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. (Hughes)

312, 313. Topology General topology (topological spaces, continuity, 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). Prerequisite:

Mathematics 201 and 203 or permission of the instructor. (Traynor) *Offered in Semester II, 1994-95.*

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. (Cunningham) *Offered in Semester II, 1994-95.*

329. Elements of Mathematical Biology Mathematical biology is the study of medicine and the life sciences, using mathematical models to help predict and interpret what we observe. The first part of this course introduces the mathematics of populations (demographics), genetics, epidemics and biogeography. The second part deals with models from neuro, cardiovascular, pulmonary and renal physiology. This course is intended to reinforce the students' mathematics education while enabling them to develop and apply modeling skills early in their academic careers. Students should be familiar with one-variable calculus and matrix theory. Prerequisite: Mathematics 203 or permission of instructor. (Carr)

351. Chaotic Dynamical Systems Limits, Cantor set, periodic points of a map, chaotic maps, maps on a circle and torus, bifurcation theory, Mandelbrot set, fractals, and Julia sets. Prerequisite: Mathematics 201. (Donnay) *Not offered in 1994-95.*

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) *Not offered in 1994-95.*

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

403. Supervised Work (staff)

Haverford College offers the following courses in mathematics:

113, 114. Calculus I and II
120. Accelerated Calculus
121. Calculus III
204. Differential Equations
210. Linear Optimization and Game Theory
215. Linear Algebra
216. Advanced Calculus
218. Introduction to Probability
317, 318. Analysis I and II
333, 334. Algebra I and II
335, 336. Topology I and II
390. Advanced Topics in Algebra and Geometry
392. Advanced Topics in Analysis and Geometry
399. Senior Seminar