College of Letters and Science • Catalog, Part

Announcement of Courses, 1964-66

This is part one of the catalog of The University of Wisconsin at Madison. The first section, "Information for Prospective Students," gives details of applying for admission, fees and tuition, living costs, student financial aids, housing, student life, and degrees.

It is also the College of Letters and Science Bulletin, with requirements and offerings listed in detail. Part two of the catalog contains reprints of the bulletins of other colleges and schools, and is intended for reference use by counseling offices, libraries, and other educational institutions.

For a list of bulletins available to prospective students, or for information on correspondence courses, Summer Sessions, graduate study, Milwaukee campus, and University Centers, turn to "Where to Write."

The Bulletin of The University of Wisconsin is published 15 times annually—once in March, April, July, August, September, October, and November; and twice in January, February, May, and June. Second-class postage is paid at Madison, Wisconsin.

Volume 1965, Number 15 • Madison, Wisconsin • November, 1965
242. (39a) European Drama and Theatre: The Age of Enlightenment and the Romantic Revolt. II; 3 cr. A continuation of Speech 241 (39), but may be taken as an independent unit; drama and theatre practice in France, Germany, Italy, and Scandinavia from 1700 to 1850. Prereq: So st. Staff.


Mathematics


Mathematics is classified both with the humanities and the sciences. Its position among the humanities is based on the study of mathematics as one of the liberal arts for more than 2,000 years. Far from becoming stagnant, mathematics offers more new and challenging frontiers than at any time in its long history—with totally new fields, requiring new techniques and ideas for exploration.

The place of mathematics among the sciences is well founded. The natural sciences have invariably turned to mathematics for the techniques needed to explore the consequences of scientific theories. Economists, psychologists, and engineers find higher mathematics of value in their training and research.

Career opportunities abound in mathematics. Teaching, both at the secondary and college level, remains a stimulating and attractive goal. The growing field of mathematical engineering has much to offer the student. For those interested in Applied Mathematics and Engineering Physics, see page 91. With additional graduate training, a student may prepare himself for a career in research in universities, industry, or government. For those interested in commerce, actuarial mathematics, used in the insurance field, offers employment opportunities with government agencies, insurance companies, or consulting firms.

Departments offering related courses are computer sciences and statistics.
Prerequisites for Beginning Courses

Four levels of preuniversity mathematical competence are specified below. Prospective science students should achieve advanced mathematical preparation before coming to the University, so they may enroll in Mathematics 231 (20) or 221 (60) at the start of their freshman year.

1. Minimum mathematical preparation (two years). From arithmetic and algebra: an understanding of the axioms that underlie arithmetic; the decimal system and its use in calculation; definition and elementary properties of rational numbers; arithmetic progressions; experience in setting up and solving linear equations and inequalities; and positive integral exponents. From geometry: axioms, theorems, and proofs of theorems concerning straight lines, triangles, and circles; graphing of linear equations; the solution of systems of two linear equations and their geometrical interpretation; formulas for volumes and surface areas of spheres, cylinders, and cones.

This level of preparation will allow a student to enroll in all majors, and fields of specialization in the College of Letters and Science. It is a prerequisite for Mathematics 101 (1).

2. Intermediate mathematical preparation. The topics listed above, together with: solution and applications of quadratic equations and inequalities, complex numbers, rational exponents, geometric progressions, graphing of circles and quadratic polynomials; definition and elementary properties of logarithms, use of tables of logarithms and other devices such as the slide rule for numerical computation.

A student normally can achieve intermediate mathematical preparation in two and one-half to three years. The level of preparation is a prerequisite for Mathematics 106 (6), and for Mathematics 240 (31).

3. Advanced mathematical preparation. The topics listed above, together with: mathematical induction, the binomial theorem, the algebra of polynomials and rational functions, the remainder and factor theorems for polynomials; functions; further selected topics in solid geometry and/or analytic geometry, preferably analytic geometry and including graphs and equations of lines, planes, circles, spheres, and other geometric figures in two and three dimensions: a deeper study of systems of linear equations, including determinants; definitions (based on arc length) and graphs of trigonometric functions, solution of right triangles, laws of sines and cosines for oblique triangles, the addition formulas and other identities relating the trigonometric functions, and solution of trigonometric equations.

A student normally can achieve advanced mathematical preparation in three to four years. This level of preparation is a prerequisite for Mathematics 231 (20), 107 (7), and 221 (60). [Mathematics 221 (60) is the first course in mathematics which carries credit in the College of Engineering.]
4. Superior mathematical preparation. Some high schools may offer topics to students with advanced mathematical preparation; for example, courses in probability and statistics, calculus (with the necessary analytic geometry) and/or topics in modern algebra are suitable for high-school students of superior ability. Students who have completed a program of study beyond advanced mathematical preparation will be placed at the University on an individual basis, by consultation between the Department of Mathematics and the student, upon recommendation of his high school.

High-School Certification and College Placement Tests

Each entering freshman should have his level of mathematical preparation certified by his high school before his registration at the University.

In addition to his certification, each entering freshman who intends to take mathematics courses in the University is required to take the Placement Examination in Mathematics at or before the time of registration. The student should review high-school mathematics, particularly algebra and trigonometry, prior to the examination.

Major

To be accepted as a major in mathematics, a student must complete Mathematics 231 (20), 232 (21), and 233 (22) (or an equivalent sequence of calculus and analytic geometry) with a grade-point average of 2.5 or better. A prospective major will ordinarily take a year's course in physics during his sophomore year, preferably Physics 207-208 (31a-b).

Required in addition are a minimum of 17 credits selected from mathematics courses numbered above 301-302 (101 a-b), which must include 3 credits in algebra, 3 credits in analysis, 3 credits in geometry, and 2 or 3 credits in Mathematics 671 (150). All students with the exception of those majoring jointly in mathematics and education are required to take at least one connected year course in one of the following: algebra, analysis, geometry (which may include topology), applied mathematics, probability and statistics, numerical analysis.

Students who elect a joint major in mathematics and education must take a minimum of 14 credits above Mathematics 301-302 (101 a-b).

Students who plan to take graduate work in mathematics should take a year course in algebra and complete a year of advanced calculus. They also should acquire a reading knowledge of two or more foreign languages as early as possible. For mathematics, the important languages are Russian, German, French, and Italian.

Mathematics Honors Courses

Honors credit is offered in the honors sections of Mathematics 231 (60), 231 (20), 232 (21), 233 (22).

To earn the B.A. or B.S. with honors the student must complete the following: (a) the general college requirements described on page 54, and (b) the requirements of the major.

Junior-senior honors curriculum: the following advanced courses: 41 (108), 521 (120a), 522 (120b), 541 (119), 563 (122), 565 (123), 567 (16) (125). In addition, any graduate course in mathematics contributing toward the honors credit. Occasionally the student will complete the year's work in a single honors course. The student must obtain permission from the course instructor, and the chairmen of honors majors must complete the year's work in a single honors course. The student must in the senior year earn 100 credits, 3 credits, Senior honors credit.

Students majoring in mathematics earn honors in the major by satisfaction of the following requirements:

Mathematics 231 (20), 232 (21), and 233 (22) are intended primarily for science students who have had the same material as 231 (20), 232 (21), and 233 (22) on physical applications.

101. (1) Introductory College Algebra. I, 3). 0-4 cr. Development of the number system and the fundamental operations of algebra, linear and quadratic equations, exponents and logarithms, variations, progressions, and Newton's binomial theorem; does not count as credit for students in engineering or for students who have had three years or more of high-school mathematics. Preliminary to a satisfactory score on the placement examination.
Regression. Some high schools may offer mathematical preparation; for example, statistics, calculus (with the necessary algebra), and modern algebra are suitable for college. Students who have completed mathematical preparation will be evaluated individually by the department, by the recommendation of the student, upon recommendation.

**College Placement Tests**

Each entering freshman who intends to major in mathematics is required to take the mathematics placement examination. The examination consists of 25 multiple-choice questions, administered on-line, with a time limit of 45 minutes. The test is designed to assess students' knowledge of algebra, geometry, trigonometry, and analytic geometry.

Students who have completed one year of high school mathematics, particularly algebra, must take the examination. Students who have completed two years of high school mathematics, particularly algebra and geometry, are encouraged to take the examination. Students who have completed at least three years of high school mathematics, particularly algebra, geometry, and trigonometry, are highly encouraged to take the examination.

**L&S General Honors Program**

To earn the B.A. or B.S. with honors, majors in mathematics must complete the following: (a) the general course degree requirements of the college, (b) the requirements of the General Honors Program as described on page 54, and (c) the junior-senior honors curriculum in the department.

The honors curriculum: Honors credit will be offered in the following advanced courses: 417 (112), 431 (115a), 432 (115b), 463 (106), 521 (120a), 522 (120b), 541 (115a), 542 (115b), 551 (121), 561 (119), 563 (122), 565 (123), 567 (166a), 568 (166b), 623 (116), and 629 (135). In addition, any graduate course taken by an undergraduate will carry honors credit. Occasionally, other courses can carry honors credit. If the student obtains permission from the departmental honors adviser, the course instructor, and the chairman of the General Honors Program, the student may complete the honors curriculum.

Honors in the Major

Students majoring in mathematics who are not honors candidates may earn honors in the major by satisfactorily completing the requirements listed above for honors candidates majoring in mathematics.

600 (Curricular Area Number)

**Elementary Courses**

There are two sequences of courses in calculus and analytic geometry. Mathematics 231 (20), 232 (21), and 233 (22) emphasize the theoretical aspects and are usually taken by letters and science students. Mathematics 221 (60), 222 (61), and 223 (62) are intended primarily for science and engineering students. They cover essentially the same material as 231 (20), 232 (21), and 233 (22), but with emphasis on physical applications.

101. (1) Introductory College Algebra. I, II; 0-4 cr. Development of the number system and the fundamental operations of algebra, linear and quadratic equations, polynomials, and logarithms. Variations, progressions, the binomial theorem; does not carry credit for students of engineering or for students who have had three or more of high-school mathematics. Prereq: Minimum mathematical preparation and a satisfactory score on the placement examination.

106. (6) Basic Algebra and Trigonometry. I, II; 0-4 cr. Number systems and equations; plane trigonometry; inequalities; functions and graphs; complex numbers; theory of equations; mathematical induction; the binomial theorem; does not carry credit for students of engineering and students who have had trigonometry in high school. Prereq: Intermediate mathematical preparation and a satisfactory score on the placement examination; or Math. 101 (1).
107. (7) Introductory Mathematics of Finance and Probability. I, II; 4 cr. Mathematical characteristics of commonly used financial growth laws, annuities, amortization, sinking funds, and bonds, the algebra of sets, elementary logic and probability, Bayes theorem, independence of events. Prereq: Completion of Math. 108 (6) or equiv; or advanced mathematics preparation and a satisfactory score on the placement examination.

109. (9) Mathematics for Elementary Teachers. I, II; 3 or 4 cr. Development of the number system with emphasis on real numbers, and the fundamental operations of algebra; approximate computation; introduction to logarithms and use of tables; graphs; elementary applications from business mathematics and statistics; other topics from college algebra, trigonometry, and analytic geometry of special value for teachers of arithmetic. Prereq: One unit each of high-school algebra and geometry; and registration in the Program for the Preparation of Elementary School Teachers.

110. (30) Elementary Statistical Analysis. [See Stat. 110 (30).] Sem; 3 cr. Elements of probability theory; collection and presentation of sample data; basic problems of statistical inference; applications, including quality control; regression; elements of statistical design. Prereq: Math. 231 (20) or 231 (60); or equiv.

201. (24) Theory of Life Insurance. I, II; 3 cr. Introduction to the mathematics of life insurance; mortality tables, net premiums, reserves, nonforfeiture benefits, gross premiums. Prereq: Two courses in mathematics.

221. (60) Calculus and Analytic Geometry. I, II; 5 cr. Introduction to differential and integral calculus and plane analytic geometry, selected topics in advanced algebra and analytic trigonometry reviewed as needed. Prereq: Advanced mathematical preparation and a satisfactory score on the placement examination; or Math. 106 (6).


223. (62) Calculus and Analytic Geometry. I, II; 5 cr. Solid analytic geometry; partial derivatives; multiple integrals; infinite series, introduction to differential equations, and/or other topics in analysis. Prereq: Math. 222 (61).

231. (20) Calculus and Analytic Geometry. I, II; 4 cr. Analytic geometry of the straight line, circle, and conics; polynomials and their graphs; elements of the differential calculus, with applications involving polynomials. Prereq: Advanced mathematical preparation and a satisfactory score on the placement examination; or Math. 106 (6).


301. (101a) Calculus. I, II; 4 cr. Functions, limits, and derivatives; differentiation of algebraic functions; differential integrals, differentiation of transcendental functions; applications; intended only for students transferring from other institutions. Prereq: Course in analytic geometry.


306. (117) Vector Analysis. Sem; 3 cr. The algebra and calculus of vectors with applications to analysis, geometry, and physics. Prereq: Math. 233 (22) or 223 (62).


309. (137a) Introduction to Mathematical Statistics. [See Stat. 309 (137a).] I, 3 or 4 cr. Philosophy of the experimental method; distribution, univariate and multivariate; moments, expected values, variances; normal distribution and derived distributions, estimation, method of least squares. Prereq: Math. 233 (22), 302 (101b), 232 (60), or equiv.

310. (137b) Introduction to Mathematical Statistics. [See Stat. 310 (137b).] II, 3 or 4 cr. Analysis of variances; orthogonal polynomials; multifactor experimental design, randomized blocks, factorial designs, composite designs; estimation of response relationships. Prereq: Math. 309 (137a).

313. (135) Actuarial Mathematics. Sem; 3 cr. Problems in finite differences, probability, and statistics with particular emphasis on applications to life insurance. Prereq: Math. 233 (22) or 223 (62).

317. (113a) Applied Mathematical Analysis. I; 3 cr. Selected topics in advanced calculus, mainly vector analysis, line and surface integrals, Jacobians and physical applications. Prereq: Math. 419 (new; replacing old 111), 417 (112), or equiv.


406. (140) Survey of the Foundations of Arithmetic. SS only; 3 cr. A course of lectures for teachers; a critical study of the numbers and operations of elementary arithmetic; rational operations and their fundamental laws, scales of notation, the unique factorization theorem for integers, the rule of casting out nines, the greatest common divisor and least common multiple, the rational fractions, the real numbers, the complex numbers,
functions, techniques of integration. Prereq: Math. 221 (60).

223. (62) Calculus and Analytic Geometry. I, II; 5 cr. Solid analytic geometry; partial derivatives; multiple integrals; infinite series; introduction to differential equations, and/or other topics in analysis. Prereq: Math. 222 (61).

231. (20) Calculus and Analytic Geometry. I, II; 4 cr. Analytic geometry of the straight line, circle, and conics; polynomials and their graphs; elements of the differential calculus, with applications involving polynomials. Prereq: Advanced mathematical preparation and a satisfactory score on the placement examination; or Math. 106 (3).


301. (101a) Calculus, I, II; 4 cr. Functions, limits, and derivatives; differentiation of algebraic function; differentials; integrals, differentiation of transcendental functions; applications; intended only for students transferring from other institutions. Prereq: Course in analytic geometry.


317. (117) Vector Analysis. Sem; 3 cr. Vector algebra and calculus of vectors with applications to analysis, geometry, and physics. Prereq: Math. 233 (22) or 223 (62).


309. (137a) Introduction to Mathematical Statistics. (See Stat. 308 (137a).) I; 3 or 4 cr. Philosophy of the experimental method; distribution, univariate and multivariate; moments, expected values, variances; normal distribution and derived distributions, estimation, method of least squares. Prereq: Math. 233 (22), 302 (101b), 223 (62), or equiv.

310. (137b) Introduction to Mathematical Statistics. (See Stat. 310 (137b).) II; 3 or 4 cr. Analysis of variances; orthogonal polynomials; multifactor experimental designs, randomized blocks, factorial designs, composite designs; estimation of response relationships. Prereq: Math. 309 (137a).

312. (113b) Applied Mathematical Analysis. I; 3 cr. Selected topics in advanced calculus, mainly vector analysis, line and surface integrals, Jacobians and physical applications. Prereq: Math. 419 (new; replacing old 111), 417 (112), or equiv.


342. (140) Survey of the Foundations of Arithmetic. SS only; 3 cr. A course of lectures for teachers; a critical study of the numbers and operations of elementary arithmetic; rational operations and their fundamental laws, properties of the integers, the rule of casting out nines, the greatest common divisor and least common multiple, the rational fractions, the real numbers, the complex numbers, fractional and negative exponents, and logarithms. Prereq: Cons instr.

343. (141) Survey of the Foundations of Algebra. SS only; 3 cr. A course of lectures, primarily designed for teachers, on the fundamental concepts of elementary algebra.

344. (169) Topics in Classical Algebra. SS; 3 cr. Selected subjects from such topics as interpolation, combinatorial analysis, continued fractions, regions in which zeros of polynomials lie, and certain aspects of the theory of determinants. Prereq: Analytic geometry and calculus.

371-372. (107a-b) Basic Concepts of Mathematics. Yr; 3 cr. Foundations of number theory, algebra, geometry, and analysis, with attention to the historical background and the recent developments in these subjects; of primary interest to teachers in the secondary schools. Prereq: Cons instr.

413. (133) Introduction to Numerical Analysis. [See Computer Sci. 413 (133).] I, II; 3 cr. Finite difference calculus, summation calculus, roots of polynomials, polynomial approximation and least squares, numerical solution of ordinary differential and integral equations and numerical quadrature; selected topics in simulation and computer programming. Prereq: Math. 233 (22) or 223 (62).

415. (131) Theory and Operation of Computing Machines. [See Computer Sci. 415 (131).] I, II; 3 cr. Programming for digital computers. Number systems; Boolean algebra, machine language programming; design, implementation and use of computer languages; introduction to systems programming; survey of modern programming methods and applications. Prereq: Math. 233 (22) or 223 (62) and elementary knowledge of Fortran (or similar computer language) programming; or cons instr.

417. (112) Introduction to Differential Equations. Sem; 3 cr. A first course in the theory of differential equations; differs from Math. 419 (new) in that stress is laid on existence and general properties of functions defined by ordinary
differential equations; recommended for mathematics majors, not open to students who have had Math. 317 (111). Prereq: Math. 233 (22) or 223 (62).


425. Linear Programming Methods. I, 3 cr. [See Computer Sci. 425 and Stat. 425.] A description of the simplex method, the revised simplex method, the dual simplex algorithm, and the primal-dual algorithm; special methods for solving transportation, transshipment, and assignment problems; parametric programming; exploitation of special structures of large-scale problems. Prereq: Math. 443 (114) or cons instr.

431. (118a) Introduction to the Theory of Probability. [See Stat. 531 (118a).] I; 3 cr. Probability in discrete sample spaces; combinatorial analysis; conditional probabilities, stochastic independence, Laplace limit theorem, Poisson distribution, laws of large numbers, random variables, applications to physics and statistics. Prereq: Math. 233 (22) or 223 (62).


443. (114) Matrices and Their Applications. Sem; 3 cr. A course in matrix theory and linear algebra of interest to students whose main field of interest is not pure mathematics. Prereq: Math. 233 (22) or 223 (62).

461. (106) College Geometry I. Sem; 3 cr. An introduction to analytic and projective geometry including a study of the conic sections and quadric surfaces, of interest to teachers in secondary schools as well as mathematics students. Prereq: Concurrent registration in Math. 233 (22), 223 (62) or cons instr.

462. (108) College Geometry II. Sem; 3 cr. Includes such topics as the foundations of Euclidean and non-Euclidean geometry, isometry and similarity in Euclidean space, algebraic curves, etc. Prereq: Math. 461 (106).

463. (109) Topics in Geometry. SS; 3 cr. A course to broaden the understanding of high-school geometry by discussion of related elementary, but modern, topics; of primary interest to teachers in secondary schools. Prereq: Math. 462 (108) or cons instr.

473. (173) History of Mathematics. Sem; 3 cr. A survey of the main lines of mathematical development from the Babylonians, Egyptians and Greeks to the present day; the lives of great mathematicians; Euclid, Archimedes, Descartes, Newton, Gauss, etc. Prereq: Cons instr.

511. (113) Symbolic Logic. [See Philos. 511 (113).] I, II; 3 cr. Formal characterization of logical truth and deductive inference, with special emphasis on the construction and discussion of symbolic systems in axiomatic form. Prereq: Cons instr.

521. (120a) Advanced Calculus. Sem; 3 cr. Fundamental notions of limits continuity, differentiation, and integration, for functions of one or more variables, convergence and uniform convergence of infinite series, and improper integrals. Applications. Prereq: Math. 233 (22) or 223 (62).


541. (115a) Modern Algebra. I; 3 cr. Vector spaces, linear transformations and matrices, systems of linear equations, determinants, characteristic roots and the minimal polynomial, groups of linear transformations. Prereq: Math. 233 (22) or 223 (62). Math. 443 (114) and 541 (115a) may not both be taken for credit.

542. (115b) Modern Algebra II; 3 cr. Unique factorization of integers and polynomials, polynomial equations, fields, rings, groups, homomorphisms. Prereq: Math. 541 (115a).

551. (121) Elementary Topology. Sem; 3 cr. Topological properties of sets in Euclidean space, and an introduction to the general theory of metric and topological spaces. Prereq: Math. 233 (22) or 223 (62).


652. (122) Projective Geometry. Sem; 3 cr. Analytic and synthetic projective geometry; finite planes, non-Euclidean planes, and the algebraic structures associated with them. Prereq: Math. 443 (114), 541 (115a), or cons instr.

655. (123) Convex Figures and Inequalities. Sem; 3 cr. Introductory course dealing with the simplest geometrical properties of convex figures and with their applications to the fundamental inequalities in use in everyday mathematical analysis. Prereq: Cons instr.


623. (116) Complex Analysis. I; 3 cr. Elementary functions of a complex variable; conformal mapping; complex integrals; the calculus of residues. Prereq: Math. 521 (120a).
Mathematics 243

629. (155) Introduction to Measure and Integration. II; 3 cr. Measure of point sets on the line; the structure of measurable functions on the line and the Lebesgue integral, basic for advanced work in probability and statistics; desirable for advanced work in analysis and applied mathematics. Prereq: Math. 421 (150a), 551 (121), or cons instr.

671. (150) Modern Views of Mathematics. 2 or 3 cr.

681-682. (100) Senior Thesis. *cr.


705. (249) Hydro and Aerodynamics. Sem; 3 cr. Prereq: Cons instr.

706. (217) Tensor Analysis. Sem; 3 cr. Algebra and calculus of tensors with particular emphasis on their applications to the theory of relativity. Prereq: Cons instr.

707-708. (250a-b) Theory of Elasticity. 3 cr.


715-716. Introduction to Applied Mathematics and Numerical Analysis. Yr; 3 cr. The mathematical formulation of physical problems; exact and approximate methods for solving the resulting equations. Prereq: 321-322 (113a-b), and 443 (114), or equiv.