Mathematics

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College of Physical and Mathematical Sciences Advisement Center
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Admission to Degree Program

The degree program in the Department of Mathematics is open enrollment.

The Discipline

Mathematics is a means of dealing with order, pattern, and number as seen in the world around us. The abilities to compute, to think logically, and to take a reasoned approach to solving problems are highly valued in society and are characteristics of any educated person. Mathematics is not just a body of knowledge, but a process of analysis, reasoning, comparison, deduction, generalization, and problem solving.

A mathematician's stock in trade is the ability to solve problems and to explain the solutions to others. Having once determined what the right questions are, solving problems involves analyzing both concrete and abstract situations, relating them to mathematical ideas, and using mathematical techniques to work toward solutions. Explaining the solution involves pointing out what has been solved and why the solution is valid.

Career Opportunities

Majors in mathematics (BS) prepare for a wide variety of careers. Some enter graduate school or professional schools and prepare for careers in such fields as college teaching, consulting, research and development, law, medicine, and business administration. Others take positions in government agencies, industrial laboratories, information management firms, or business organizations. All of them spend much time communicating with colleagues about the problems they are solving as they continue to learn more mathematics and share mathematical ideas with others.

Graduation Requirements

To receive a bachelor's degree a student must fill three groups of requirements: (1) general education requirements; (2) university requirements; and (3) major requirements.

General Education Requirements

Students should contact their college advisement center for information about general education courses that will also fill major requirements.

Languages of Learning

Precollege Math (zero to one course) . . . . . 0–3.0 hours (or Math ACT score of at least 22)
First-Year Writing (one course) 3.0
Advanced Writing (one course) 3.0
Advanced Languages/Math/Music (one to four courses) 3–20.0

Liberal Arts Core

Biological Science (one to two courses) 3–6.0
Physical Science (one to two courses) 3–7.0
American Heritage (one to two courses) 3–6.0
Wellness (one to three courses) 1.5–2.0
Civilization (two courses) 6.0

Arts and Sciences Electives

Arts and Letters (one course) 3.0
Natural Sciences (one course) 3–4.0
Social and Behavioral Sciences (one course) 3.0

Note 1: For a complete list of courses that will fill each GE category, see the General Education section of the current class schedule.

Note 2: Additional information about general education requirements can be found in the General Education section of the current class schedule or this catalog.

Minimum University Requirements

Religion 14.0
Residency 30.0
Hours needed to graduate 120.0
Cumulative GPA must be at least 2.0.

Note: See the Graduation section of this catalog for more information.

Major Requirements

Complete the major requirements listed under the following undergraduate degree program.

Undergraduate Programs and Degrees

BS Mathematics
Minor Mathematics

Students should see their college advisement center for help or information concerning the undergraduate programs.

Graduate Programs and Degrees

MS Mathematics
PhD Mathematics

For more information see the BYU 2003–2004 Graduate Catalog.

Advisement

Upon completion of five core courses (from Math 112H, 113H, 190, 214, 343), undergraduate majors are required to meet with an assigned faculty advisor. Students whose grade point average is less than a B in the first four core courses need to realize that advanced courses require much more depth of understanding and may be difficult for them.

Students who are considering graduate work in mathematics may receive advice from the graduate coordinator.

General Information

1. It is recommended that a student complete the following courses in high school:

   4 units of English
   1 unit of physics or chemistry.
   4 units of mathematics, including 2.5 units of algebra, 1 unit of geometry, and .5 unit of trigonometry. This qualifies a student to begin college mathematics with Math 112H. If calculus is available in high school, a student planning to major in mathematics is strongly encouraged to take it; doing so requires completing one of the preceding algebra units before high school.

   Advanced Placement (AP) credit is available in mathematics as follows:

   A score of 3 on the calculus AB exam gives credit in Math 110 and 111; a score of 4 or 5 on the calculus AB exam gives credit in Math 110 and 112.
   A score of 3, 4, or 5 on the calculus BC exam gives credit in Math 112 and 113.

An AP student without credit in Math 112 must begin with Math 112H; an AP student without credit in Math 113 must begin with Math 112H or 113H.
AP students with credit in Math 113 are urged to begin with Math 113H anyway, unless they scored 5 on the calculus BC exam.
AP students should direct Educational Testing Service (ETS) to report scores to BYU to have credit posted.

Questions regarding placement should be directed to the Mathematics Department, 292 TMCB.

2. Majors are strongly urged to study Phscs 121 and 220 during their first two years.
3. It is strongly recommended that RelC 491 be taken during the senior year.

BS Mathematics (53 hours*)

Major Requirements

1. Grades of C– or below will not be acceptable in major courses.
2. Complete the following core requirements:
   Math 112H, 113H, 190, 214, 315, 334, 343, 371.
3. Complete the following:
   Math 316, 332.
4. Complete the following:
   CS 142.
5. Complete one of the following:
   Stat 321, 421.
6. After consulting with a faculty advisor, complete four courses from one of the following areas of specialization (at least one 500-level course must be included):
   Applied mathematics: Math 347, 511, 521, 522, 534, 535, 541, 542, 547, 570.
   Discrete math and geometry: Math 350, 355, 362, 387, 532, 551, 552, 570.
   Numerical analysis: Math 311, 347, 411, 511, 512.
   Pure mathematics: Math 372, 387, 532, 541, 542, 551, 552.
7. Complete an additional 3 hours from the following:
   Math 300, 311, 347, 350, 355, 362, 372, 387, 411, 460R, 480, 495R, 501, 502, 511, 512, 513R, 521, 522, 530, 532, 534, 535, 541, 542, 543, 547, 551, 552, 561, 562, 570.
   Phscs 517.
8. Students who continue toward graduate work should complete Math 372, 532, 541, and 542.
9. Those planning for doctoral work should also complete Math 551 and 552 and are advised to gain competence in one or two languages from French, German, and Russian.
10. Students are required to take the advanced math GRE before their final semester of study.

Recommended Courses

Phscs 121, 220.

*Hours include courses that may fulfill GE or university requirements.

Minor Mathematics (20 hours*)

Minor Requirements

1. Grades of C– or below will not be accepted.
2. Complete the following courses:
   Math 112, 113, 343.
3. Complete one course from the following:
   Math 214, 315, 316.
4. Complete 6 hours from the following:
   Math 300, 311, 315, 316, 332, 334, 347, 350, 355, 362, 371, 372, 387, or any 400- or 500-level mathematics course.

*Hours include courses that may fulfill GE or university requirements.

Mathematics (Math)

Undergraduate Courses

Note: For courses containing material preparatory to Math 97 (up through beginning algebra) please refer to Independent Study.

97. Intermediate Algebra. (0:2:1) F, W, Sp, Su Independent Study also. Prerequisite: high school algebra.
Elementary logic, real number system, equations and inequalities (linear, polynomial, rational, and radical expressions), graphing, function notation, inverse function, exponential functions, systems of equations, variations. Fee.

110. College Algebra. (3:3:0) F, W, Sp, Su Independent Study also. Prerequisite: Math 97 or equivalent.
Functions, polynomials, theory of equations, exponential and logarithmic functions, matrices, determinants, systems of linear equations, permutations, combinations, binomial theorem.

111. Trigonometry. (2:2:0) F, W, Sp, Su Independent Study also. Prerequisite: Math 110 or equivalent.
Circular functions, triangle relationships, identities, inverse trig functions, trigonometric equations, vectors, complex numbers, DeMoivre's theorem.

112. Calculus 1. (4:5:0) F, W, Sp, Su Honors also. Prerequisite: Math 110 and 111 or equivalent.
Differential and integral calculus: limits; continuity; the derivative and applications; extrema; the definite integral; fundamental theorem of calculus; L'Hôpital's rule.

113. Calculus 2. (4:5:0) F, W, Sp, Su Honors also. Prerequisite: Math 112 or equivalent.
Techniques and applications of integration; sequences, series, convergence tests, power series; parametric equations; polar coordinates; gradients; directional derivatives; iterated integrals.

119. Introduction to Calculus. (4:4:1) For students in the College of Biology and Agriculture and the Marriott School of Management. Independent Study also. F, W, Sp, Su Prerequisite: Math 110 or equivalent.
Introduction to plane analytic geometry and calculus.

190. Fundamentals of Mathematics. (3:3:0) F, W, Su Prerequisite: Math 112 or concurrent enrollment with instructor's consent.
Achieving maturity in mathematical communication. Introduction to mathematical proof; methods of proof; analysis of proof; induction; logical reasoning.

212. Advanced Engineering Mathematics. (3:3:0) F, W, Sp Prerequisite: Math 113 or equivalent.
Vectors, linear algebra, and vector calculus. Not applicable for the math minor.

214. Calculus of Several Variables. (3:3:0) F, W, Sp, Su Prerequisite: Math 113; 343 or concurrent enrollment.
Partial differentiation, the Jacobian matrix, and integral theorems of vector calculus.

300. History of Mathematics. (3:3:0) F, W, Su Independent Study also. Prerequisite: Math 113.
Development of mathematics, emphasizing underlying principles and motivations.

302. Mathematics for Engineering 1. (4:4:0) F, W Prerequisite: Math 113 and passing grade on required preparatory exam taken during first week of class. (Practice exams available on class Web site.)
Multivariable calculus, linear algebra, and numerical methods.

303. Mathematics for Engineering 2. (4:4:0) F, W Prerequisite: Math 302; or Math 214 and 343.
ODEs, Laplace transforms, Fourier series, PDEs, numerical methods.

311. Introduction to Numerical Methods. (3:3:0) F, W Prerequisite: calculus and knowledge of a programming language.
Root finding, interpolation, curve fitting, numerical differentiation and integration, multiple integrals, direct solvers for linear systems, least squares, rational approximations, fourier and other orthogonal methods.

315, 316. Theory of Analysis. (3:3:0 ea.) 315: F, W; 316: F, W Prerequisite: for 315: Math 113, 190, 343; for 316: Math 315.
Rigorous treatment of calculus of single and several variables. Topics include uniform continuity, metric spaces, Riemann integral, implicit function theorem, and integral theorems of vector calculus.

332. Introduction to Complex Analysis. (3:3:0) F, W Prerequisite: Math 214 or 316.
Complex algebra, analytic functions, integration in the complex plane, infinite series, theory of residues, conformal mapping.

334. Ordinary Differential Equations. (3:3:0) F, W, Sp, Su Prerequisite: Math 113; 212 or 343.
Methods and theory of ordinary differential equations.

343. Elementary Linear Algebra. (3:3:0) F, W, Sp, Su Prerequisite: Math 112 or 119.
Linear systems, matrices, vectors and vector spaces, linear transformations, determinants, inner product spaces, eigenvalues, and eigenvectors.

347. Introduction to Partial Differential Equations. (3:3:0) W, Su Prerequisite: Math 213 or 334.
Boundary value problems; transform methods; Fourier series; Bessel functions; Legendre polynomials.

350. Combinatorics. (3:3:0) Prerequisite: Math 343, 371.
Permutations, combinations, recurrence relations, applications.

355. Graph Theory. (3:3:0) Prerequisite: Math 343.
Maps, graphs and digraphs, coloring problems, applications.

362. Survey of Geometry. (3:3:0) F, W, Su Independent Study also. Prerequisite: Math 112, 190.
Logical structure of Euclidean, non-Euclidean, and finite geometries.

371, 372. Abstract Algebra. (3:3:0 ea.) 371: F, W, Sp; 372: W Prerequisite: for 371: Math 190, 343; for 372: Math 371.
Groups, rings, fields, vector spaces, linear transformations, matrices, field extensions, etc.

387. Number Theory. (3:3:0) Prerequisite: Math 343, 371.
Foundations; congruences; quadratic reciprocity; unique factorization, prime distribution or Diophantine equations.

391R. Seminar in Mathematics. (1:1:0) F
Topics from classical problems of antiquity, combinatorial mathematics, graph theory, real functions, number theory, functional equations.

399R. Academic Internship. (1–9:9:0 ea.) On dem.
On-the-job experience.

411. Numerical Methods. (3:3:0) W Prerequisite: Math 311, 334.
Iterative solvers for linear systems, eigenvalue, eigenvector approximations, numerical solutions to nonlinear systems, numerical techniques for initial and boundary value problems, elementary solvers for PDEs.

460R. Topics in Geometry. (3:3:0 ea.) On dem. Prerequisite: Math 343, 362, or equivalent.
Topics selected from the various aspects of synthetic, analytic, algebraic, and differential geometry.

480. Mathematical Models. (3:3:0) On dem. Prerequisite: Math 214, 311, 343; 213 or 334.
Construction, solution, and interpretation of discrete and continuous models applied to problems in the physical, natural, and social sciences.

495R. Readings in Mathematics. (1–2:0:3 ea.) F, W, Sp, Su Prerequisite: instructor's consent.
Directed readings beyond the scope of usual undergraduate courses.

499R. Senior Thesis. (1–3:0:3 ea.) F, W, Sp, Su

500-Level Graduate Courses (available to advanced undergraduates)

501. Real Numbers. (3:3:0) On dem. Prerequisite: Math 371.
Extensive examination of various axiomatic descriptions of real numbers and interrelationships among these descriptions.

502. Set Theory. (3:3:0) On dem. Prerequisite: Math 371.
Zermelo-Fraenkel axioms for set theory, the axiom of choice, ordinal and cardinal numbers, and algebra of sets.

511. Numerical Methods for Partial Differential Equations. (3:3:0) F Prerequisite: Math 311, 343; 213 or 347; or equivalent.
Finite difference and finite volume methods for partial differential equations. Stability, consistency, and convergence theory.

512. Numerical Analysis. (3:3:0) W Prerequisite: Math 311, 343, or instructor's consent.
Numerical matrix algebra, orthogonalization and least squares methods, unsymmetric and symmetric eigenvalue problems, iterative methods, Lanczos methods, advanced solvers for partial differential equations.

513R. Advanced Topics in Applied Mathematics. (3:3:0 ea.) On dem. Prerequisite: instructor's consent.

521, 522. Methods of Applied Mathematics. (3:3:0 ea.) 521:Alt. F; 522: Alt. W Prerequisite: Math 334.
Survey of current methods, continuous and discrete, including linear algebra, estimation, differential equations of equilibrium, eigenvalue and initial value problems; finite element, spectral, transform, and difference methods; Fourier series, the Fourier matrix, fast Fourier transform; convolution.

530. Calculus of Variations. (3:3:0) On dem. Prerequisite: Math 213 or 334; 343. Recommended: Math 315, 347.
Euler-Lagrange equation, sufficient conditions, Hamilton's principle of least action, Dirichlet's principle; applications to mechanics, geometry, economics, eigenvalue problems, direct methods.

532. Complex Analysis. (3:3:0) Prerequisite: Math 332 or instructor's consent.
Introduction to theory of complex analysis at beginning graduate level. Topics: Cauchy integral equations, Riemann surfaces, Picard's theorem, etc.

534. Introduction to Dynamical Systems 1. (3:3:0) Prerequisite: Math 315, 334; or equivalents.
Discrete dynamical systems; iterations of maps on the line and the plane; bifurcation theory; chaos, Julia sets, and fractals. Computational experimentation.

535. Introduction to Dynamical Systems 2. (3:3:0)
Continuous dynamical systems; introduction to invariant manifold theory; stability; bifurcation; low-dimensional chaotic systems; attractors.

541, 542. Real Analysis. (3:3:0 ea.) F, W Prerequisite: Math 315, 343; 214 or 316.
Rigorous treatment of differentiation and integration theory; Lebesque measure; Banach spaces.

543. Advanced Probability. (3:3:0) Prerequisite: Math 214, Stat 341.
Advanced combinatorial methods, random walk, Markov chains, and stochastic processes.

547. Partial Differential Equations. (3:3:0) Prerequisite: Math 334; 214 or 316.
Topics from elliptic equations, heat equations, wave equations, stability, Fourier methods, energy methods, existence of solutions, etc.

551, 552. Introduction to Topology. (3:3:0 ea.) F, W Prerequisite: Math 315.
Axiomatic treatment of linearly ordered spaces, metric spaces, arcs, and Jordan curves; types of connectedness.

561, 562. Introduction to Algebraic Geometry. (3:3:0) Prerequisite: Math 671 or concurrent enrollment.
Projective varieties, curves, surfaces, differential forms, and divisors.

570. Matrix Analysis. (3:3:0) Prerequisite: Math 343; or 212, 213; or equivalents.
Special classes of matrices, canonical forms, matrix and vector norms, localization of eigenvalues, matrix functions, applications.

587. Introduction to Analytic Number Theory. (3:3:0) F or W Prerequisite: Math 332 or equivalent; instructor's consent.
Arithmetical functions; distribution of primes; Dirichlet characters; Dirichlet's theorem; Gauss sums; primitive roots; Dirichlet L-functions; Riemann zeta-function; prime number theorem; partitions.

588. Introduction to Algebraic Number Theory. (3:3:0) F or W Prerequisite: Math 372 or equivalent; instructor's consent.
Algebraic integers, different and discriminant; decomposition of primes; class group; Dirichlet unit theorem; Dedekind zeta-function; cyclotomic fields; valuations; completions.

Graduate Courses

For 600- and 700-level courses, see the BYU 2003–2004 Graduate Catalog.

Mathematics Faculty

Orson Pratt Professor
Cannon, James W. (1986) BA, PhD, U. of Utah, 1967, 1969.

Professors
Baker, Roger C. (1991) BSc, PhD, U. of London, England, 1968, 1971.
Barrett, Wayne W. (1981) BS, U. of Utah, 1968; MS, PhD, New York U., 1975, 1975.
Bates, Peter W. (1984) BS, Queen Mary Coll., U. of London, England, 1969; PhD, U. of Utah, 1976.
Fearnley, Lawrence (1957) BS, U. of London, 1953; PhD, U. of Utah, 1959; PhD, U. of London, 1970.
Forcade, Rodney W. (1981) BS, MS, U. of Chicago, 1961, 1963; PhD, U. of Washington, 1971.
Garner, Lynn E. (1963) BS, Brigham Young U., 1962; MA, U. of Utah, 1964; PhD, U. of Oregon, 1968.
Humphries, Stephen P. (1987) BSc, MSc, PhD, U. of Wales, 1974, 1978, 1983.
Kuttler, Kenneth L. (1999) BS, MS, Brigham Young U., 1974, 1976; PhD, U. of Texas, Austin, 1981.
Lamoreaux, Jack W. (1968) BS, Brigham Young U., 1960; MS, PhD, U. of Utah, 1964, 1967.
Lang, William E. (1989) BA, Carleton Coll., 1974; MS, Yale U., 1975; PhD, Harvard U., 1978.
Lu, Kening (1990) BS, MS, Sichuan U., China, 1982, 1985; PhD, Michigan State U., 1988.
Ouyang, Tiancheng (1992) MS, Naukai U., China, 1981; PhD, U. of Minnesota, 1989.
Pollington, Andrew D. (1982) BS, MS, PhD, U. of London, 1975, 1976, 1978.
Smith, William V. (1985) BS, PhD, U. of Utah, 1973, 1978.
Wright, David G. (1983) BS, Brigham Young U., 1970; MA, PhD, U. of Wisconsin, Madison, 1972, 1973.

Associate Professors
Chahal, Jasbir S. (1981) MA, Punjab U., India, 1970; PhD, Johns Hopkins U., 1979.
Chow, Shue-Sum (1998) BS, U. of Canterbury, New Zealand, 1979; PhD, Australian National U., Australia, 1983.
Clark, David A. (1993) BA, U. of Utah, 1985; MSc, PhD, McGill U., Canada, 1988, 1992.
Conner, Gregory R. (1992) BA, Humboldt State U., 1987; MS, PhD, U. of Utah, 1989, 1992.
Grant, Christopher P. (1993) BS, MS, Brigham Young U., 1986, 1988; PhD, U. of Utah, 1991.
Jarvis, Tyler (1996) BS, MS, Brigham Young U., 1989, 1990; MA, PhD, Princeton U., 1992, 1994.
Skarda, R. Vencil (1965) BA, Pomona Coll., 1961; MS, PhD, California Inst. of Technology, 1964, 1965.
Tolman, L. Kirk (1965) BS, MS, Brigham Young U., 1960, 1961; PhD, U. of New Mexico, 1972.
Villamizar, Vianey (2000) BS, MS, Universidad Central de Venezuela, 1977, 1983; PhD, Rensselaer Polytechnic Inst., 1987.

Assistant Professors
Cardon, David A. (1998) BS, Brigham Young U., 1990; MS, PhD, Stanford U., 1993, 1996.
Dallon, John (1999) BA, MA, PhD, U. of Utah, 1989, 1991, 1996.
Dorff, Michael (2000) BA, Brigham Young U., 1986; MS, U. of New Hampshire, 1992; PhD, U. of Kentucky, 1997.
Doud, Darrin M. (2001) BS, MS, Brigham Young U., 1992, 1993; MS, PhD, U. of Illinois, 1999, 1999.
Glasgow, Scott (2000) BS, Brigham Young U., 1988; PhD, U. of Arizona, 1993.
Halverson, Denise M. (2001) BS, MS, Brigham Young U., 1989, 1994; PhD, U. of Tennessee, 1999.
Li, Xian-Jin (2001) BS, Hunan Normal U., China, 1982; MS, Academia Sinica, Beijing, China, 1985; PhD, Purdue U., 1993.
Swenson, Eric L. (1998) BS, PhD, Brigham Young U., 1987, 1993.

Emeriti
Chatterley, Louis J. (1962) BS, Brigham Young U., 1955; MS, U. of Utah, 1962; PhD, U. of Texas, Austin, 1972.
Clawson, Robert G. (1979) AA, Pasadena City Coll., 1960; BA, California State U., Los Angeles, 1963; MS, U. of South Dakota, 1971.
Crawley, Peter L. (1971) BS, PhD, California Inst. of Technology, 1957, 1961.
Fletcher, Harvey J., Jr. (1980) BS, Massachusetts Inst. of Technology, 1944; MS, California Inst. of Technology, 1948; PhD, U. of Utah, 1954.
Garbe, Douglas G. (1963) AS, Snow Coll., 1956; BS, Brigham Young U., 1962; MS, U. of Oregon, 1967; PhD, U. of Texas, Austin, 1973.
Gee, Burton C. (1960) BS, Brigham Young U., 1951; MS, EdD, Oregon State U., 1958, 1965.
Gill, Gurcharan S. (1960) BS, Brigham Young U., 1958; M.S, PhD, U. of Utah, 1960, 1965.
Hansen, Richard A. (1967) BS, MS, PhD, U. of Utah, 1959, 1961, 1965.
Haupt, Floyd E. (1954) BS, MS, U. of Arizona, 1947, 1948.
Hillam, Kenneth L. (1957) BS, MS, U. of Utah, 1949, 1956; PhD, U. of Colorado, 1962.
Jamison, Ronald D. (1963) BS, Brigham Young U., 1957; PhD, U. of Utah, 1965.
Larsen, Kenneth M. (1960) BA, U. of Utah, 1950; MA, Brigham Young U., 1956; PhD, U. of California, Los Angeles, 1964.
Moore, Hal G (1961) BS, MS, U. of Utah, 1952, 1957; PhD, U. of California, Santa Barbara, 1967.
Robinson, Donald W. (1956) BS, MA, U. of Utah, 1948, 1952; PhD, Case Inst. of Technology, 1956.
Snow, Donald Ray (1969) BA, BS, U. of Utah, 1959, 1959; MS, MS, PhD, Stanford U., 1960, 1962, 1965.

Wickes, Harry E. (1957) BS, MEd, Brigham Young U., 1950, 1954; MEd, Harvard U., 1962; EdD, Colorado State U., 1967.
Wight, Theodore A. (1963) BS, MS, EdD, U. of Utah, 1955, 1964, 1969.
Wynn, Jan Eugene (1966) BS, BS, U. of Idaho, 1962, 1962; MS, Utah State U., 1965; PhD, Colorado State U., 1972.