

## MATHEMATICS (MATH)

### Courses

#### **MATH 1012. College Algebra. 3 Credits.**

Sets, relations, functions with particular attention to properties of algebraic, exponential, logarithmic functions, their graphs and applications in preparation for MATH 1212. May not be taken for credit concurrently with, or following receipt of, credit for any mathematics course numbered MATH 1212 or above. Pre/co-requisites: Two years of secondary school algebra; one year of secondary school geometry. Catamount Core: QR.

#### **MATH 1034. Pre-Calculus Mathematics. 3 Credits.**

Skills in working with numerical, algebraic, and trigonometric expressions are developed in preparation for MATH 1234. May not be taken for credit concurrently with, or following receipt of, credit for any mathematics course numbered MATH 1234 or above. Prerequisite: Two years of secondary school algebra; one year of secondary school geometry. Catamount Core: QR.

#### **MATH 1077. Exploring Modern Mathematics. 3 Credits.**

Introduction to mathematics of finite systems with applications, such as probability, statistics, graph theory, fair division and apportionment problems, voting systems. Prerequisites: Two years of secondary school algebra, MATH 1012, or MATH 1034. Catamount Core: MA, QR.

#### **MATH 1088. Numbers for Naturalists. 3 Credits.**

Data, statistics, modeling, algebra, word problems, and calculus for students in the Rubenstein School of Environment and Natural Resources. Students who do well in the algebra section may continue with MATH 1212 or MATH 1234. Credit not awarded to College of Engineering and Mathematical Sciences students. Prerequisite: Three years of high school math. Catamount Core: MA, QR.

#### **MATH 1111. Elementary School Math. 3 Credits.**

Operations with real numbers: decimals, fractions, percents, integers. Set operations, Venn diagrams, algebra, and problem solving provide background for future instruction in elementary/middle school mathematics. Prerequisite: Three years of secondary school math. Catamount Core: MA, QR.

#### **MATH 1122. Fund Cncpts Elm School Math. 3 Credits.**

Topics include geometry, measurement, probability, statistics, algebra, number theory, and problem solving to provide background for future instruction in elementary and middle school mathematics. Prerequisite: Three years of secondary school math. Catamount Core: QR.

#### **MATH 1212. Fundamentals of Calculus I. 3 Credits.**

Introduction to limits and differential/integral calculus with a wide variety of applications. Students interested in intensive use of mathematics should take MATH 1234. Credit not awarded for both MATH 1212 and MATH 1234 unless followed by MATH 1248. See MATH 1242. Prerequisite: C- or better in MATH 1012 or C- or better in MATH 1034, or a score of 61 or higher on the placement assessment. Catamount Core: MA, QR.

#### **MATH 1224. Fundamentals of Calculus II. 3 Credits.**

Techniques and applications of integration. An introduction to multi-variable calculus: partial derivatives and double integrals. Prerequisite: MATH 1212 or MATH 1234. Catamount Core: MA, QR.

#### **MATH 1234. Calculus I. 4 Credits.**

Introduction to calculus of functions of one variable including: limits, continuity, techniques and applications of differentiation and integration. Credit not given for more than one course in the pair MATH 1212, MATH 1234 unless followed by MATH 1248 or MATH 1242. No credit following receipt of credit for MATH 1248 or above. Prerequisite: C- or better in MATH 1034 or a score of 76 or higher on the placement assessment. Catamount Core: MA, QR.

#### **MATH 1242. Transitional Calculus. 5 Credits.**

Intended to make the transition from MATH 1212 to MATH 2248. Topics are similar to MATH 1248 but recognizing different backgrounds of students in MATH 1212 versus MATH 1234. Credit will not be given for both MATH 1248 and MATH 1242. No credit following receipt of credit for MATH 2248 or above. Prerequisite: B or better in MATH 1212, or B or better in MATH 1224. Catamount Core: MA, QR.

#### **MATH 1248. Calculus II. 4 Credits.**

Vectors and vector operations. Techniques and applications of integration. Polar coordinates, Taylor polynomials, sequences and series, power series. Credit will not be given for both MATH 1248 and MATH 1242. No credit following receipt of credit for MATH 2248 or above. Prerequisite: C- or better in MATH 1234. Catamount Core: MA, QR.

#### **MATH 1990. Special Topics. 1-18 Credits.**

Introductory courses or seminars on topics beyond the scope of existing departmental offerings. See Schedule of Courses for specific titles. Prerequisite: Instructor permission.

#### **MATH 1991. Internship. 1-3 Credits.**

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

#### **MATH 1993. Independent Study. 1-18 Credits.**

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

#### **MATH 2001. Development of Mathematics. 3 Credits.**

Project-based course. Historical development of mathematical sciences emphasizing interrelations among them. Individual assignments correspond to background and interests of students. Prerequisite: Nine hours of college mathematics.

**MATH 2055. Fundamentals of Mathematics. 3 Credits.**

Emphasizing proofs, fundamental mathematical concepts and techniques are investigated within the context of number theory and other topics. Prerequisite: MATH 1234 or MATH 1242. Credit not given for more than one of MATH 2055 and CS 1640. Catamount Core: MA, QR.

**MATH 2111. Algebra for Educators. 3 Credits.**

Algebraic concepts and relationships are explored and developed. Linear, quadratic, and exponential functions are featured. Credit not awarded for students majoring or minoring in Mathematics. Prerequisite: 3 credits of Math numbered MATH 1111 or above. Catamount Core: QR.

**MATH 2180. Geometry for Educators. 3 Credits.**

An examination of geometric relationships using reasoning and proof. Topics include Euclidean, non-Euclidean and finite geometries, affine transformations, constructions, and spatial geometry. Provides background for future instruction in middle and high school geometry. Credit not awarded for students majoring or minoring in Mathematics. Prerequisites: Three credits of Mathematics at MATH 1111 or above, minimum Sophomore standing.

**MATH 2248. Calculus III. 4 Credits.**

Vector-valued functions. Calculus of functions of several variables: partial derivatives, gradient, divergence, curl, multiple integrals, line integrals, Stokes' and Green's theorems. Prerequisite: C- or better in MATH 1248 or MATH 1242. Catamount Core: MA, QR.

**MATH 2468. Real Anlys in One Variable. 3 Credits.**

Principles of analysis in one variable. Heine-Borel and Bolzano-Weierstrass theorems; rigorous development of differential and integral calculus; infinite sequences and series of functions. May not be taken concurrently with or after MATH 3468. Prerequisite: MATH 2055 (preferred) or CS 1640. Catamount Core: MA, QR.

**MATH 2500. Eng Math Linear Algebra Lab. 1 Credit.**

Survey of the fundamental concepts of linear algebra necessary to describe the solution space of a linear differential equation and for solving systems of linear differential equations. Credit not awarded following receipt of credit for MATH 2522 or MATH 2544. Prerequisite: MATH 1234. Co-requisites: MATH 1248 or MATH 1242.

**MATH 2522. Applied Linear Algebra. 3 Credits.**

Vectors, matrices, linear independence, vector spaces (with focus on real  $n$ -space), determinants, linear transformations, eigenvalues and eigenvectors. Applications from engineering and the sciences incorporated through required computer assignments. Credit not given for both MATH 2522 and MATH 2544. Prerequisite: MATH 1248 or MATH 1242. Catamount Core: MA, QR.

**MATH 2544. Linear Algebra. 3 Credits.**

Vector spaces, linear independence, bases, linear transformations, matrices, determinants, change of basis characteristic equations, eigenvalues and eigenvectors, with applications. Emphasis on understanding and gaining facility with these concepts including proofs. Credit not given for both MATH 2522 and MATH 2544. Prerequisite: MATH 1248 or MATH 1242. Co-requisite: MATH 2248 or MATH 2055. Catamount Core: MA, QR.

**MATH 2551. Groups and Rings. 3 Credits.**

An introduction to the basic concepts of abstract algebra emphasizing examples, including modular arithmetic, symmetric groups, cyclic groups, polynomial rings, homomorphisms, and isomorphisms. May not be taken concurrently with or after MATH 3551. Prerequisite: MATH 2055 (preferred) or CS 1640. Catamount Core: MA, QR.

**MATH 2678. Basic Combinatorial Theory. 3 Credits.**

Introduction to basic combinatorial principles emphasizing problem-solving techniques. Enumeration, generating functions, Fibonacci numbers, pigeonhole principle, inclusion-exclusion, and graph theory. Prerequisites: MATH 2055 (preferred) or CS 1640. Catamount Core: MA, QR.

**MATH 2700. Fndmntls of Financial Math. 3 Credits.**

Students will be introduced to the basic ideas and algebraic structures of interest theory, time-value of money, annuities, loans, bonds, cash-flows and portfolios. Prerequisites: MATH 1224, MATH 1248 or MATH 1242. Catamount Core: QR.

**MATH 2990. Special Topics. 1-18 Credits.**

See Schedule of Courses for specific titles.

**MATH 2991. Internship. 1-18 Credits.**

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

**MATH 2993. Independent Study. 1-18 Credits.**

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion. Prerequisite: Junior/Senior standing; approval of Department Chair.

**MATH 2994. Teaching Assistantship. 1-3 Credits.**

Undergraduate student service as a teaching assistant, usually in an introductory level course in the discipline, for which credit is awarded. Offered at department discretion.

**MATH 2995. Undergraduate Research. 1-18 Credits.**

Undergraduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

**MATH 3201. Adv Engineering Mathematics. 3 Credits.**

Differential equations, Laplace transforms, and systems of differential equations; brief introduction to Fourier series. Examples from engineering and physical sciences. Credit not granted for both MATH 3230 and MATH 3201. No credit for Mathematics majors. Prerequisite: MATH 2248. Co-requisites: Preferred: MATH 2522 or MATH 2544; or MATH 2500. Catamount Core: QR.

**MATH 3230. Ordinary Diffrentl Equation. 3 Credits.**

Solutions of linear ordinary differential equations, the Laplace transformation, and series solutions of differential equations. Prerequisite: MATH 2248. Corequisite: MATH 2522 or MATH 2544. Credit not granted for more than one of the courses MATH 3230 or MATH 3201. Catamount Core: QR.

**MATH 3456. Complex Analysis. 3 Credits.**

An introduction to the theory of analytic functions of one complex variable, covering the techniques of complex analysis useful in science and engineering as well as the theory. Topics include complex numbers, analytic and holomorphic functions, power and Laurent series expansions, and Cauchy's theorems on integration. Prerequisites: MATH 2055 or CS 1640; MATH 2248. Catamount Core: QR.

**MATH 3468. Anyl in Several Real Vars I. 3 Credits.**

Properties of the real numbers, basic topology of metric spaces, infinite sequences and series, continuity. Prerequisites: MATH 2468 or MATH 2551 or C- or better in MATH 2055; MATH 2248; MATH 2522 or MATH 2544. Catamount Core: QR.

**MATH 3472. Anyl Several Real Vrbes II. 3 Credits.**

Differentiation and integration in n-space, uniform convergence of functions, fundamental theorem of calculus, inverse and implicit function theorems. Prerequisite: MATH 3468. Catamount Core: QR.

**MATH 3517. Elementary Number Theory. 3 Credits.**

Divisibility, prime numbers, Diophantine equations, congruence of numbers, and methods of solving congruences. A significant portion of the course devoted to individual and/or team projects. Prerequisites: MATH 2055 or CS 1640; MATH 2248, MATH 2522, or MATH 2544. Catamount Core: QR.

**MATH 3551. Abstract Algebra I. 3 Credits.**

Basic theory of groups, rings, fields, homomorphisms, and isomorphisms. Prerequisites: MATH 2468 or MATH 2551 or C- or better in MATH 2055; MATH 2522 or MATH 2544. Catamount Core: QR.

**MATH 3555. Abstract Algebra II. 3 Credits.**

Modules, vector spaces, linear transformations, rational and Jordan canonical forms. Finite fields, field extensions, and Galois theory leading to the insolvability of quintic equations. Prerequisite: MATH 3551. Catamount Core: QR.

**MATH 3559. Cryptography. 3 Credits.**

A survey of classical and modern cryptography. Topics include the strengths and weaknesses of various cryptosystems, specific public-key and private-key cryptosystems such as RSA, ElGamal, and elliptic curve cryptosystems, as well as digital signatures and key exchange. Prerequisite: MATH 2055 or CS 1640; MATH 2248, MATH 2522, or MATH 2544. Cross-listed with: CS 3559.

**MATH 3737. Intro to Numerical Analysis. 3 Credits.**

Error analysis, root-finding, interpolation, least squares, quadrature, linear equations, numerical solution of ordinary differential equations. Credit not awarded for both MATH 3737 and MATH 5737. Prerequisites: MATH 2248; MATH 2522, MATH 2544, or MATH 3201; CS 1210. Cross-listed with: CS 3737. Catamount Core: QR.

**MATH 3766. Chaos,Fractals&Dymncal Syst. 3 Credits.**

Discrete and continuous dynamical systems, Julia sets, the Mandelbrot set, period doubling, renormalization, Henon map, phase plane analysis and Lorenz equations. Credit not awarded for both MATH 3766 and CSYS 5766 or MATH 5766. Prerequisite: MATH 2522 or MATH 2544; CS 1210 recommended. Catamount Core: QR.

**MATH 3990. Special Topics. 1-18 Credits.**

For advanced students in the indicated fields. Lectures, reports, and directed readings on advanced topics. Credit as arranged. Offered as occasion warrants.

**MATH 3991. Internship. 1-18 Credits.**

On-site supervised work experience combined with a structured academic learning plan directed by a faculty member or a faculty-staff team in which a faculty member is the instructor of record, for which academic credit is awarded. Offered at department discretion.

**MATH 3993. Independent Study. 1-18 Credits.**

A course which is tailored to fit the interests of a specific student, which occurs outside the traditional classroom/laboratory setting under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

**MATH 3994. Teaching Assistantship. 1-3 Credits.**

Undergraduate student service as a teaching assistant, usually in an introductory level course in the discipline, for which credit is awarded. Offered at department discretion.

**MATH 3995. Undergraduate Research. 1-18 Credits.**

Undergraduate student work on individual or small team research projects under the supervision of a faculty member, for which credit is awarded. Offered at department discretion.

**MATH 4344. Topology. 3 Credits.**

Capstone course that includes a final project. An introduction to point set topology. Topics include open and closed sets, continuous functions, compactness, connectedness, metric and Hausdorff spaces. Provides a background for analysis and graduate topology courses as well as for topological data science. Prerequisites: MATH 2055 or CS 1640; MATH 2248, MATH 2522, or MATH 2544; one 3-credit course in WIL1. Catamount Core: QR, WIL2.

**MATH 4788. Exploring Biomathematics. 3 Credits.**

Capstone course; students develop, apply and document mathematical approaches to biological and ecological problems. Coursework includes discussions on ethics in science, problem solving, computer (dry lab) assignments, and analysis of research papers and technical writing. Prerequisites: MATH 2522 or MATH 2544; MATH 3230 or MATH 3201; one 3-credit course designated WIL1. Catamount Core: WIL2.

**MATH 4990. Special Topics. 1-18 Credits.**

See Schedule of Courses for specific titles.

**MATH 4996. Undergraduate Honors Thesis. 1-6 Credits.**

Program of reading and research culminating in written thesis and oral presentation. Honors notation appears on transcript and Commencement Program. Contact department chairperson for procedures.