MATHEMATICS (MATH)

undefined

MATH Courses

MATH 92. Beginning Algebra Review. 3 units
Term Typically Offered: TBD
CR/NC
Review of basic algebra skills at the beginning algebra level intended primarily to prepare students for MATH 96. Course open only to students who have taken the ELM examination and are not qualified for MATH 96. Not for baccalaureate credit. Credit/No Credit grading only. 3 lectures.

MATH 94. Beginning Algebra Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 92.

Facilitated study and discussion of the theory, problems, and applications of beginning algebra. Not for baccalaureate credit. Credit/No Credit grading only. 1 laboratory.

MATH 95. Stretch Precalculus Algebra I Workshop. 1 unit
Term Typically Offered: F
CR/NC
Prerequisite: Appropriate Math Placement Level. Concurrent: MATH 115.

Review of basic algebra skills intended primarily to prepare students for the precalculus content in MATH 115. Not for baccalaureate credit. Credit/No Credit grading only. 1 activity.

MATH 96. Intermediate Algebra. 3 units
Term Typically Offered: TBD
CR/NC
Prerequisite: Appropriate score on the ELM examination, or credit in MATH 92.

Review of basic algebra skills at the intermediate algebra level intended primarily to prepare students for MATH 116. Not for baccalaureate credit. Credit/No Credit grading only. 3 lectures.

MATH 98. Intermediate Algebra Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 96.

Facilitated study and discussion of the theory, problems, and applications of intermediate algebra. Not for baccalaureate credit. Credit/No Credit grading only. 1 laboratory.

MATH 112. Nature of Modern Math. 4 units
Term Typically Offered: W, SP
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 95 or appropriate Math Placement Level.

Topics from contemporary mathematics, their development, applications, and role in society. Some typical topics to be chosen by the instructor: graph theory, critical path analysis, statistical inference, coding, game theory, and symmetry. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE Area.

MATH 115. Stretch Precalculus Algebra I. 3 units
Term Typically Offered: F
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: Appropriate Math Placement Level. Concurrent: MATH 95.

First course in precalculus college algebra without trigonometry, with built-in review of basic algebra skills necessary to be successful in precalculus. Factoring, exponents, and radicals. Real and complex numbers. Modeling with equations and inequalities. Linear, quadratic, and polynomial functions and their graphs. MATH 115 or MATH 116, and MATH 117 are equivalent to MATH 118, but are taught at a slower pace. Upon completion of MATH 115 or MATH 116, and MATH 117, a student will receive 4 units of GE credit for Area B4. A grade of C- or better is required in one course in GE Area B4 to fulfill General Education requirements. Not open to students with credit in MATH 116, MATH 118, MATH 141, MATH 161, or MATH 221. 3 lectures.

MATH 116. Precalculus Algebra I. 3 units
Term Typically Offered: TBD
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 96 or appropriate Math Placement Level.

First course in precalculus college algebra without trigonometry. Factoring, exponents, and radicals. Real and complex numbers. Modeling with equations and inequalities. Linear, quadratic, and polynomial functions and their graphs. MATH 115 or MATH 116, and MATH 117 are equivalent to MATH 118, but are taught at a slower pace. Upon completion of MATH 115 or MATH 116, and MATH 117, a student will receive 4 units of GE credit for Area B4. A grade of C- or better is required in one course in GE Area B4 to fulfill General Education requirements. Not open to students with credit in MATH 115, MATH 118, MATH 141, MATH 161, or MATH 221. Credit will be granted in only one of the following courses: MATH 115, MATH 116, or MATH 118. 3 lectures.

MATH 117. Precalculus Algebra II. 3 units
Term Typically Offered: W
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 115 with a grade of C- or better; or MATH 116 with a grade of C- or better; or consent of instructor.

Second course in precalculus college algebra without trigonometry. Rational, exponential, and logarithmic functions. Matrices, determinants, and systems of linear equations. MATH 115 or MATH 116, and MATH 117 are equivalent to MATH 118, but are taught at a slower pace. Upon completion of MATH 115 or MATH 116, and MATH 117, a student will receive 4 units of GE credit for Area B4. A grade of C- or better is required in one course in GE Area B4 to fulfill General Education requirements. Not open to students with credit in MATH 118. 3 lectures.

MATH 118. Precalculus Algebra. 4 units
Term Typically Offered: F,W,SP,SU
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: Appropriate Math Level Placement.

Precalculus algebra without trigonometry. Factoring, exponents, and radicals. Real and complex numbers. Modeling with equations and inequalities. Rational, exponential, and logarithmic functions. Matrices, determinants, and systems of linear equations. MATH 118 is equivalent to MATH 115 or MATH 116, and MATH 117. Not open to students with credit in MATH 117, MATH 141, MATH 161, or MATH 221. Credit will be granted in only one of the following courses: MATH 115, MATH 116, or MATH 118. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 119. Precalculus Trigonometry. 4 units
Term Typically Offered: F, W, SP
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: Appropriate Math Placement Level.

Rectangular and polar coordinates. Trigonometric functions, fundamental identities. Inverse trigonometric functions and relations. Complex numbers, conic sections, and analytic geometry. Not open to students with credit in MATH 141, MATH 161, or MATH 221. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 126. Pre-Calculus Algebra Workshop I. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 116.

Facilitated study and discussion of the theory, problems, and applications of precalculus algebra. Credit/No Credit grading only. 1 laboratory.

MATH 127. Pre-Calculus Algebra Workshop II. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 117.

Facilitated study and discussion of the theory, problems, and applications of pre-calculus algebra. Credit/No Credit grading only. 1 laboratory.

MATH 128. Pre-Calculus Algebra Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 118.

Facilitated study and discussion of the theory, problems, and applications of pre-calculus algebra. Credit/No Credit grading only. 1 laboratory.

MATH 129. Precalculus Trigonometry Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Corequisite: Concurrent enrollment in the associated section of MATH 119.

Facilitated study and discussion of the theory, problems, and applications of pre-calculus trigonometry. Credit/No Credit grading only. 1 laboratory.

MATH 141. Calculus I. 4 units
Term Typically Offered: F,W,SP,SU
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: Appropriate Math Placement Level; or MATH 117 and high school trigonometry; or MATH 118 and high school trigonometry; or MATH 119.

Limits, continuity, differentiation. Introduction to integration. 4 lectures. Crosslisted as HNRS/MATH 141. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 142. Calculus II. 4 units
Term Typically Offered: F,W,SP,SU
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 141 with a grade of C- or better or consent of instructor.

Techniques of integration, applications to physics, transcendental functions. 4 lectures. Crosslisted as HNRS/MATH 142. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 143. Calculus III. 4 units
Term Typically Offered: F,W,SP,SU
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 142 with a grade of C- or better or consent of instructor.

Infinite sequences and series, vector algebra, parametric curves. 4 lectures. Crosslisted as HNRS/MATH 143. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 151. Calculus Workshop I. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 141.

Facilitated study and discussion of the theory, problems, and applications of calculus. Credit/No Credit grading only. 1 laboratory.

MATH 152. Calculus Workshop II. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 142.

Facilitated study and discussion of the theory, problems, and applications of calculus. Credit/No Credit grading only. 1 laboratory.

MATH 153. Calculus Workshop III. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 143.

Facilitated study and discussion of the theory, problems, and applications of calculus. Credit/No Credit grading only. 1 laboratory.

MATH 161. Calculus for the Life Sciences I. 4 units
Term Typically Offered: W, SP, SU
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: Appropriate Math Placement Level; or MATH 117; or MATH 118; or MATH 119.

Differential calculus with applications in the biological sciences. Review of exponential, logarithmic, and trigonometric functions. Limits, continuity, differentiation. Examples, exercises, and applications to emphasize problems in the biological sciences. Not open to students with credit in MATH 141. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 162. Calculus for the Life Sciences II. 4 units
Term Typically Offered: F, SP, SU
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 161.

Integral calculus with applications in the biological sciences. Techniques of integration. Matrices, partial derivatives, and introduction to differential equations and mathematical modeling. Examples, exercises, and applications to emphasize problems in the biological sciences. Not open to students with credit in MATH 142. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 171. Calculus for the Life Sciences Workshop I. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 161.

Facilitated study and discussion of the theory, problems, and applications of calculus for the life sciences. Credit/No Credit grading only. 1 laboratory.

MATH 172. Calculus for the Life Sciences Workshop II. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 162.

Facilitated study and discussion of the theory, problems, and applications of calculus for the life sciences. Credit/No Credit grading only. 1 laboratory.

MATH 182. Calculus for Architecture and Construction Management. 4 units
Term Typically Offered: W, SP
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 141.

Integral calculus with applications to architecture and construction management. The algebra of vectors. Polar, cylindrical, and spherical coordinate systems. Not open to students with credit in MATH 142. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 192. Calculus for Architecture and Construction Management Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 182.

Facilitated study and discussion of the theory, problems, and applications of calculus to architecture and construction management. Credit/No Credit grading only. 1 laboratory.

MATH 202. Orientation to Mathematics Major. 1 unit
Term Typically Offered: F, SP
CR/NC
Prerequisite: MATH 143.

Career opportunities in the field of mathematics, preparing a field of study, and a survey of departmental facilities and procedures related to research, study and graduation. Credit/No Credit grading only. 1 lecture.

MATH 206. Linear Algebra I. 4 units
Term Typically Offered: F,W,SP,SU
Prerequisite: MATH 122 or MATH 143.

Systems of linear equations. Matrix algebra, including inverses and determinants. Vectors, vector spaces, bases and linear transformations in real coordinate space of n dimensions. Eigenvalues, eigenvectors and diagonalization. Applications of linear algebra. Introduction to inner products and orthogonality. 4 lectures.

MATH 221. Calculus for Business and Economics. 4 units
Term Typically Offered: W, SP
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: Appropriate Math Placement Level; or MATH 117; or MATH 118; or MATH 119.

Limits, continuity, differentiation. Exponential and logarithmic functions. Introduction to integration. Examples, exercises and applications to emphasize problems in business and economics. Not open to students with credit in MATH 141. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 227. Mathematics for Elementary Teaching I. 4 units
Term Typically Offered: F, W
2020-21 or later catalog: GE Area B4
2019-20 or earlier catalog: GE Area B1
Prerequisite: MATH 95 or appropriate Math Placement Level.

Introduction to problem solving, set theory, number systems, arithmetic operations, models, and number theory. This class is designed for Liberal Studies majors. Other students will be admitted by consent of instructor. 4 lectures. Fulfills GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); a grade of C- or better is required in one course in this GE area.

MATH 231. Calculus for Business and Economics Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 221.

Facilitated study and discussion of the theory, problems, and applications of business calculus. Credit/No Credit grading only. 1 laboratory.

MATH 241. Calculus IV. 4 units
Term Typically Offered: F,W,SP,SU
Prerequisite: MATH 143.

Partial derivatives, multiple integrals, introduction to vector analysis. 4 lectures. Crosslisted as HNRS/MATH 241.

MATH 242. Differential Equations I. 4 units
Term Typically Offered: W, SP
Prerequisite: MATH 206; and MATH 123 or MATH 241.

Ordinary differential equations: first-order linear equations, separable equations, exact equations, second-order linear equations, nonhomogeneous equations, systems of first-order linear equations, systems of nonlinear equations, modeling and applications. Not open to students with credit in MATH 244. 4 lectures.

MATH 244. Linear Analysis I. 4 units
Term Typically Offered: F,W,SP,SU
Prerequisite: MATH 122 or MATH 143.

Separable and linear ordinary differential equations with selected applications; numerical and analytical solutions. Linear algebra: vectors in n-space, matrices, linear transformations, eigenvalues, eigenvectors, diagonalization; applications to the study of systems of linear differential equations. 4 lectures. Crosslisted as HNRS/MATH 244.

MATH 248. Methods of Proof in Mathematics. 4 units
Term Typically Offered: F,W,SP,SU
Prerequisite: MATH 123 or MATH 143.

Methods of proof (direct, contradiction, conditional, contraposition); valid and invalid arguments. Examples from set theory. Quantified statements and their negations. Functions, indexed sets, set functions. Proofs in number theory, algebra, geometry and analysis. Proof by induction. Equivalence and well-defined operations and functions. The axiomatic method. 4 lectures.

MATH 251. Calculus Workshop IV. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 241.

Facilitated study and discussion of the theory, problems, and applications of calculus. Credit/No Credit grading only. 1 laboratory.

MATH 253. Introduction to Mathematical Optimization. 4 units
Term Typically Offered: W, SP
Prerequisite: MATH 123 or MATH 241; and MATH 206.

Algorithms and mathematical analysis for solving optimization problems. One-dimensional search methods; Newton's method extended to multi-dimensional optimization problems and gradient methods. The basic mathematics of neural networks and examples of their application. Optimization problems with equality and inequality constraints. 4 lectures.

MATH 254. Linear Analysis Workshop I. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 244.

Facilitated study and discussion of the theory, problems, and applications of linear analysis. Credit/No Credit grading only. 1 laboratory.

MATH 258. Methods of Proof in Mathematics Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 248.

Facilitated study and discussion of the methods and techniques of proof in mathematics. Credit/No Credit grading only. 1 laboratory.

MATH 270. Selected Topics. 1-4 units
Term Typically Offered: TBD
Prerequisite: Consent of instructor.

Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

MATH 300. Technology in Mathematics Education. 4 units
Term Typically Offered: F
Prerequisite: MATH 248.

Examination of existing hardware and software designed for educational uses. Discussion of mathematical topics appropriate for computer enhancement. Special methods and techniques for educational uses of computers. Emphasis on activity learning and applications. Computer as a classroom management device. 4 lectures.

MATH 304. Vector Analysis. 4 units
Term Typically Offered: W, SP
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing or Mathematics major; completion of GE Area A with grades of C- or better; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); MATH 206 or MATH 244; and Math 241.

Differential and integral calculus of vector-valued functions. Green's Theorem, Stokes' Theorem, and the Divergence Theorem. Applications and generalizations. 4 lectures. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

MATH 306. Linear Algebra II. 4 units
Term Typically Offered: F, W, SP
Prerequisite: MATH 206 or MATH 244; and MATH 123 or MATH 143; and MATH 248 with a grade of C- or better or consent of instructor.

Rigorous development of real and complex vector spaces, including infinite dimensional spaces. Subspaces, bases, products and direct sums. Examples and properties of linear transformations. Similarity, eigenvalues, eigenvectors and diagonalization. Characteristic and minimal polynomials, Cayley-Hamilton Theorem. 4 lectures.

MATH 316. Introduction to Linear Algebra Workshop II. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 306.

Facilitated study and discussion of the methods and techniques of proof in linear algebra. Credit/No Credit grading only. 1 laboratory.

MATH 328. Mathematics for Elementary Teaching II. 4 units
Term Typically Offered: W, SP
Prerequisite: MATH 227 with a grade of C- or better or consent of instructor.

Introduction to rational and real numbers, probability and counting techniques, statistics, and proportional reasoning. Computer applications. 4 lectures.

MATH 329. Mathematics for Elementary Teaching III. 4 units
Term Typically Offered: F, SP
Prerequisite: MATH 328.

Introduction to concepts of Euclidean geometry, including shape, visualization and attributes of measurement, with an emphasis on problem solving and critical thinking. Computer applications. 4 lectures.

MATH 330. Algebraic Thinking with Technology. 4 units
Term Typically Offered: F, W
Prerequisite: MATH 329.

Algebraic concepts for elementary teachers. Mathematical patterns, equations and inequalities, linear and quadratic functions, exponential and logarithmic functions, systems of equations, roots of polynomials, factoring of polynomials, and right-triangle trigonometry. Computer applications. 4 lectures.

MATH 334. Combinatorial Math. 4 units
Term Typically Offered: F, W
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing or Mathematics major; completion of GE Area A with grades of C- or better; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or or earlier catalogs); and one of the following courses: CSC 248, MATH 206, or MATH 248.

Methods of enumerative combinatorics: sum, product, and division rules, bijective and recursive techniques, inclusion and exclusion, and generating functions. Advanced topics to be selected from the theory of partitions, finite difference calculus, Polya theory, designs, and codes. 4 lectures. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

MATH 335. Graph Theory. 4 units
Term Typically Offered: F
Prerequisite: MATH 248 or junior standing.

Introduction to graph theory and its applications: isomorphism, paths and searching, connectedness, trees, tournaments, planarity, graph colorings, matching theory, network flow, adjacency and incidence matrices. Further topics to be selected from the theory of finite state machines, Ramsey theory, extremal theory, and graphical enumeration. 4 lectures.

MATH 341. Theory of Numbers. 4 units
Term Typically Offered: SP
Prerequisite: MATH 248 with a grade of C- or better or consent of instructor.

Properties of numbers. Euclid's Algorithm, greatest common divisors, diophantine equations, prime numbers, congruences, number theoretic functions, the quadratic reciprocity laws, primitive roots and indices. 4 lectures.

MATH 344. Linear Analysis II. 4 units
Term Typically Offered: F, W, SP
2020-21 or later: Upper-Div GE Area B
2019-20 or earlier catalog: GE Area B5, B6, or B7
Prerequisite: Junior standing or one of the following majors: BMED, MATH, or ME; completion of GE Area A with grades of C- or better; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and MATH 242 or MATH 244; and MATH 123 or MATH 241.

Linear methods applied to the solution of differential equations. Laplace transforms. Series solutions to ordinary differential equations. Orthogonality in n-space, Gram-Schmidt orthogonalization and least squares methods. Orthogonal bases in function spaces, Sturm-Liouville theory. Fourier series and transforms. Special functions of applied mathematics. 4 lectures. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

MATH 350. Mathematical Software. 4 units
Term Typically Offered: SP
Prerequisite: MATH 206 or MATH 244, and MATH 241, and an introductory college-level programming course, or consent of instructor.

Problem-solving using mathematical software. 4 lectures.

MATH 351. Typesetting with LaTeX. 1 unit
Term Typically Offered: W
CR/NC
Prerequisite: Junior standing.

Preparing documents, especially mathematical ones, using LaTeX and AMS-LaTeX. Credit/No Credit grading only. 1 lecture.

MATH 370. Putnam Exam Seminar. 2 units
Term Typically Offered: F
Prerequisite: Consent of instructor.

Directed group study of mathematical problem solving techniques. Open to undergraduate students only. Class members are expected to participate in the annual William Lowell Putnam Mathematical Competition. Course may be repeated up to eight units. 2 seminars.

MATH 371. Math Modeling Seminar. 2 units
Term Typically Offered: F
Prerequisite: Consent of instructor.

Directed group study of mathematical modeling techniques. Open to undergraduate students only. Class members are expected to participate in the annual Mathematical Competition in Modeling. Total credit limited to 8 units. 2 seminars.

MATH 400. Special Problems for Advanced Undergraduates. 1-4 units
Term Typically Offered: F,W,SP,SU
Prerequisite: Junior standing and consent of department chair.

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units.

MATH 404. Introduction to Differential Geometry. 4 units
Term Typically Offered: F
Prerequisite: MATH 304.

Theory of curves and surfaces in space. Topics such as Frenet formulas, curvature, geodesics, Cartan structural equations, Gauss-Bonnet Theorem. 4 lectures.

MATH 406. Linear Algebra III. 4 units
Term Typically Offered: SP
Prerequisite: MATH 306.

Rigorous development of real and complex inner product spaces. Orthogonal bases and direct sums of subspaces. Linear transformations on inner product spaces. Properties of self-adjoint and normal operators. Additional topics such as the Jordan Decomposition Theorem and the Spectral Theorem. 4 lectures.

MATH 410. Complex Analysis I. 4 units
Term Typically Offered: F
Prerequisite: MATH 242, or MATH 241 and MATH 244.

Geometry of the complex plane, analytic functions, the Cauchy-Riemann equations, and harmonic functions. Contour integrals, the Cauchy-Goursat theorem, and Cauchy integral formulas. Maximum modulus and mean value properties. Taylor and Laurent series, the calculus of residues, and applications to integration. 4 lectures.

MATH 411. Complex Analysis II. 4 units
Term Typically Offered: W
Prerequisite: MATH 408 or MATH 410.

Further applications of the calculus of residues, analytic continuation, Rouche's theorem, and the argument principle. Conformal maps, the Riemann mapping theorem, Mobius transformations and applications. Additional topics may include Riemann surfaces, special functions, Weierstrass and Hadamard factorization, and asymptotic methods. 4 lectures. Formerly MATH 409.

MATH 412. Introduction to Analysis I. 4 units
Term Typically Offered: F, W
Prerequisite: MATH 306.

Introduction to concepts and methods basic to real analysis. Topics such as the real number system, sequences, continuity, uniform continuity and differentiation. 4 lectures.

MATH 413. Introduction to Analysis II. 4 units
Term Typically Offered: W, SP
Prerequisite: MATH 412.

A continuation of Introduction to Analysis I covering such topics as integration, infinite series, uniform convergence and functions of several variables. 4 lectures.

MATH 414. Introduction to Analysis III. 4 units
Term Typically Offered: SP
Prerequisite: MATH 413.

Continuation of Introduction to Analysis II covering such topics as differentiation and integration of functions of several variables and other advanced topics. 4 lectures.

MATH 416. Differential Equations II. 4 units
Term Typically Offered: F, W
Prerequisite: MATH 242 or MATH 244; and MATH 123 or MATH 241.

Qualitative theory of ordinary differential equations: Existence and Uniqueness Theorem, phase portraits, limit sets, stability of fixed points and periodic orbits, energy functions, Poincare-Bendixson Theorem, Poincare maps, bifurcations, attractors, chaos. 4 lectures.

MATH 418. Partial Differential Equations. 4 units
Term Typically Offered: F, SP
Prerequisite: MATH 344. Recommended: MATH 304.

Mathematical formulation of physical laws. Separation of variables. Orthogonal functions and generalized Fourier series. Bessel functions, Legendre polynomials. Sturm-Liouville problem. Boundary value problems; nonhomogeneous techniques. Applications to heat flow, potential theory, vibrating strings and membranes. 4 lectures.

MATH 419. Introduction to the History of Mathematics. 4 units
Term Typically Offered: W
Prerequisite: MATH 248 with a grade of C- or better and at least one upper division course in mathematics, or consent of instructor.

Evolution of mathematics from earliest to modern times. Major trends in mathematical thought, the interplay of mathematical and technological innovations, and the contributions of great mathematicians. Appropriate for prospective and in-service teachers. 4 lectures.

MATH 422. Introduction to Analysis I Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 412.

Facilitated study and discussion of the methods and techniques of proof in introductory analysis. Credit/No Credit grading only. 1 laboratory.

MATH 423. Advanced Mathematics for Teaching. 4 units
Term Typically Offered: SP
Prerequisite: MATH 442 and MATH 481.

Introduction to mathematics education research and advanced exploration of the mathematics taught in California's public high schools and middle schools through problem analysis, concept analysis, and problem connections. 4 lectures.

MATH 424. Organizing and Teaching Mathematics. 4 units
Term Typically Offered: F
CR/NC
Prerequisite: Acceptance into the Mathematics Single Subject Credential Program.

Organization, selection, presentation, application and interpretation of subject matter in mathematics. Introduction to current issues in mathematics education. For students who will be teaching in secondary schools. Credit/No Credit grading only. 4 lectures.

MATH 425. Mathematics Student Teaching Seminar. 2 units
Term Typically Offered: W, SP
CR/NC
Prerequisite: Acceptance into Step II of the Single Subject Credential Program in Mathematics. Concurrent: EDUC 469 or EDUC 479.

Principles and practice in effective teaching of mathematics at the middle and high school level, learning theories, curriculum content and structure, classroom issues, and the teaching profession. Credit/No Credit grading only. Total credit limited to 4 units. 2 seminars.

MATH 435. Discrete Mathematics with Applications I. 4 units
Term Typically Offered: F
Prerequisite: MATH 248 with a grade of C- or better and MATH 334 or MATH 336, or consent of instructor.

Methods of discrete mathematics with applications. Generating functions and Lagrange inversion, partition theory, permutation statistics and q-analogues, posets and Moebius inversion. Additional topics including lattice paths and basic hypergeometric series. 4 lectures. Not open to students with credit in MATH 530.

MATH 436. Discrete Math with Applications II. 4 units
Term Typically Offered: TBD
Prerequisite: MATH 435. Corequisite: MATH 482.

Methods of discrete mathematics with applications. Polya theory, codes, designs, matroids, the combinatorics of symmetric functions, and tableaux combinatorics. Additional topics including transversals and Latin squares, asymptotics, and discrete probability theory. 4 lectures. Not open to students with credit in MATH 531.

MATH 437. Game Theory. 4 units
Term Typically Offered: SP
Prerequisite: MATH 206 or MATH 244, and MATH 248 with a grade of C- or better, or consent of instructor.

Development of the mathematical concepts, techniques, and models used to investigate optimal strategies in competitive situations; games in extensive, normal, and characteristic form, Nash equilibrium points and Nash Bargaining Model. 4 lectures.

MATH 440. Topology I. 4 units
Term Typically Offered: W
Prerequisite: MATH 412. Corequisite: MATH 481.

Introduction to general topological spaces with emphasis on surfaces and manifolds. Open and closed sets, continuity, compactness, connectedness. Quotient spaces. 4 lectures. Not open to students with credit in MATH 540.

MATH 441. Topology II. 4 units
Term Typically Offered: TBD
Prerequisite: MATH 440.

Introduction to general topological spaces with emphasis on surfaces and manifolds. Fundamental group. Triangulations of spaces, classification of surfaces. Other topics may include covering spaces, simplicial homology, homotopy theory and topics from differential topology. 4 lectures. Not open to students with credit in MATH 541.

MATH 442. Euclidean Geometry. 4 units
Term Typically Offered: W
Prerequisite: MATH 248 with a grade of C- or better or consent of instructor. Recommended: MATH 300 or familiarity with dynamic geometry software.

Foundations of Euclidean geometry, finite geometries, congruence, similarities, polygonal regions, circles and spheres. Constructions, mensuration, the parallel postulate. Appropriate for prospective and in-service mathematics teachers. 4 lectures.

MATH 443. Modern Geometries. 4 units
Term Typically Offered: SP
Prerequisite: MATH 442.

Non-Euclidean and projective geometries. Properties of parallels, biangles, Saccheri and Lambert quadrilaterals, angle-sum and area. Limiting curves: hyperbolic trigonometry, duality, perspectivity, quadrangles, fundamental theorems of projective geometry, conics. 4 lectures.

MATH 451. Numerical Analysis I. 4 units
Term Typically Offered: W
Prerequisite: MATH 242 or MATH 244; and MATH 123 or MATH 241; and an introductory college-level programming course.

Topics in interpolation and approximation methods, initial value problems, and boundary value problems of ordinary differential equations. 4 lectures.

MATH 452. Numerical Analysis II. 4 units
Term Typically Offered: SP
Prerequisite: MATH 451.

Numerical techniques for solving partial differential equations of the parabolic, hyperbolic and elliptic type. Further topics in approximation theory. 4 lectures.

MATH 453. Numerical Optimization. 4 units
Term Typically Offered: SP
Prerequisite: MATH 306 and MATH 451.

Algorithms for solving optimization problems that cannot be solved analytically. Descent algorithms including exact and practical line-searches, steepest descent method, and Newton and quasi-Newton methods for unconstrained minimization. Optimality conditions for constrained optimization, linear programming. Projection and Lagrangian methods, and interior point methods for constrained minimization. 4 lectures.

MATH 459. Senior Project Seminar. 4 units
Term Typically Offered: F, SP
Prerequisite: MATH 412 or MATH 481.

Written and oral analyses and presentations by students on topics from advanced mathematics and mathematical modeling. Not open to students with credit in MATH 460. 4 seminars.

MATH 460. Senior Project Applied Seminar. 4 units
Term Typically Offered: F
Prerequisite: CSC/CPE 101 or MATH 350; MATH 306; and MATH 344.

Written and oral analyses and presentations by students on topics in applied mathematics, including applications to sustainability. Construction of mathematical models for physical and biological problems, with analysis and interpretation of the solutions of these models using both analytical and numerical techniques. Not open to students with credit in MATH 459. 4 seminars.

MATH 461. Senior Project I. 2 units
Term Typically Offered: F,W,SP,SU
Prerequisite: Senior Standing.

Selection and development of a mathematics project under faculty supervision. Minimum 60 hours total time.

MATH 462. Senior Project II. 2 units
Term Typically Offered: F,W,SP,SU
Prerequisite: MATH 461.

Completion of a mathematics project under faculty supervision. Project results are presented in a formal report. Minimum 60 hours total time.

MATH 470. Selected Advanced Topics. 1-4 units
Term Typically Offered: TBD
Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 lectures.

MATH 474. Advanced Topics in Geometry and Topology. 1 unit
Term Typically Offered: TBD
Prerequisite: MATH 248 and consent of instructor. Recommended: MATH 404 and MATH 440.

Exploration of advanced topics and problems in geometry and topology through reading, writing and oral presentations. The Class Schedule will list topic selected. Total credit limited to 6 units. 1 seminar.

MATH 475. Advanced Topics in Mathematics. 4 units
Term Typically Offered: TBD
Prerequisite: MATH 306 and consent of instructor.

Exploration of advanced topics and problems in mathematics. The Class Schedule will list topic selected. Total credit limited to 8 units. 4 lectures.

MATH 476. Advanced Topics in Applied Mathematics. 4 units
Term Typically Offered: TBD
Prerequisite: MATH 306 and consent of instructor.

Exploration of advanced topics and problems in applied mathematics. The Class Schedule will list topic selected. Total credit limited to 8 units. 4 lectures.

MATH 481. Abstract Algebra I. 4 units
Term Typically Offered: F, W
Prerequisite: MATH 306 or MATH 341.

Introduction to the study of groups. Topics include groups of permutations, cyclic groups, normal subgroups and quotient groups. Homomorphisms, Lagrange's Theorem, Cayley's Theorem, the Isomorphism Theorems and the Fundamental Theorem of Finite Abelian Groups. 4 lectures.

MATH 482. Abstract Algebra II. 4 units
Term Typically Offered: W, SP
Prerequisite: MATH 481.

Introduction to rings and fields. Reducible and irreducible polynomials, ideals, prime and maximal ideals, quotient rings, ring homomorphisms, the Isomorphism Theorems, integral domains, unique factorization domains, principal ideal domains, Euclidean domains, fields of fractions, field extensions and finite fields. 4 lectures.

MATH 483. Abstract Algebra III. 4 units
Term Typically Offered: SP
Prerequisite: MATH 482.

Algebraic field extensions, the tower law, ruler-and-compass constructions, the primitive element theorem, algebraic and transcendental numbers, algebraic closure, the fundamental theorem of algebra, finite fields, Galois extensions and the fundamental theorem of Galois theory. Not open to students with credit in MATH 560. 4 lectures.

MATH 485. Cooperative Education Experience. 6 units
Term Typically Offered: TBD
CR/NC
Prerequisite: Consent of instructor.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. No major credit allowed; total credit limited to 12 units. Credit/No Credit grading only.

MATH 491. Abstract Algebra I Workshop. 1 unit
Term Typically Offered: TBD
CR/NC
Concurrent: Enrollment in the associated section of MATH 481.

Facilitated study and discussion of the methods and techniques of proof in abstract algebra. Credit/No Credit grading only. 1 laboratory.

MATH 495. Cooperative Education Experience. 12 units
Term Typically Offered: TBD
CR/NC
Prerequisite: Consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. No major credit allowed; total credit limited to 12 units. Credit/No Credit grading only.

MATH 500. Individual Study. 1-4 units
Term Typically Offered: F,W,SP,SU
Prerequisite: Graduate standing and consent of department chair.

Individual research or advanced study planned and completed under the direction of a departmental faculty member. Open only to graduate students demonstrating ability to do independent work. Total credit limited to 12 units.

MATH 501. Analytic Methods in Applied Mathematics. 4 units
Term Typically Offered: F
Prerequisite: MATH 344 or AERO 300, and graduate standing.

Introduction to advanced methods of mathematics useful in the analysis of engineering problems. Selected topics in perturbation theory, optimization and Fourier analysis. Not open to students in math major or master's degree program in mathematics. 4 lectures.

MATH 502. Numerical Methods in Applied Mathematics. 4 units
Term Typically Offered: W
Prerequisite: Graduate standing, or CSC/CPE 101 or CSC 231 or CSC 232; and one of the following: AERO 300 or EE 228 or MATH 344 or PHYS 321.

Introduction to advanced numerical analysis. Numerical techniques for solving ordinary and partial differential equations, error analysis, stability, methods for linear systems. 4 lectures.

MATH 505. Graduate Teaching Seminar. 1 unit
Term Typically Offered: F
CR/NC
Prerequisite: Graduate standing.

Principles and practice in effective teaching of college-level mathematics. Issues related to present and future teaching experiences, including time management, professionalism, student assessment, grading, classroom management, and qualities of good mathematics teachers. Reflection on individual teaching, and consideration of improvements in instruction. Credit/No Credit grading only. Total credit limited to 2 units. 1 seminar.

MATH 520. Applied Analysis I. 4 units
Term Typically Offered: W
Prerequisite: MATH 408 or MATH 410; MATH 412; and graduate standing. Recommended: MATH 418.

Advanced mathematical methods of applied mathematics, integrated with modeling of physical phenomena. Topics include dimensional analysis, applications of complex analysis, and advanced techniques for ordinary differential equations. Additional topics selected from dynamical systems, calculus of variations, or other applied subjects. 4 lectures.

MATH 521. Applied Analysis II. 4 units
Term Typically Offered: SP
Prerequisite: MATH 520.

Advanced mathematical methods of applied mathematics, integrated with modeling of physical phenomena. Topics include asymptotic expansions, advanced techniques for partial differential equations, and Fourier analysis. Additional topics selected from integral equations, discrete time systems, numerical analysis, or other applied subjects. 4 lectures.

MATH 530. Discrete Mathematics with Applications I. 4 units
Term Typically Offered: F
Prerequisite: MATH 248 with a grade of C- or better and MATH 334 or MATH 336 and graduate standing, or consent of instructor.

Methods of discrete mathematics with applications. Generating functions and Lagrange inversion, partition theory, permutation statistics and q-analogues, posets and Möbius inversion. Additional topics including lattice paths and basic hypergeometric series. 4 lectures. Not open to students with credit in MATH 435.

MATH 531. Discrete Mathematics with Applications II. 4 units
Term Typically Offered: W
Prerequisite: MATH 435 or MATH 530. Corequisite: MATH 482 or graduate standing in Mathematics.

Methods of discrete mathematics with applications. Polya theory, codes, designs, matroids, the combinatorics of symmetric functions, and tableaux combinatorics. Additional topics including transversals and Latin squares, asymptotics, and discrete probability theory. 4 lectures. Not open to students with credit in MATH 436.

MATH 540. Topology I. 4 units
Term Typically Offered: W
Prerequisite: MATH 412 or graduate standing in Mathematics. Corequisite: MATH 481 or graduate standing in Mathematics.

Introduction to general topological spaces with emphasis on surfaces and manifolds. Open and closed sets, continuity, compactness, connectedness. Quotient spaces. 4 lectures. Not open to students with credit in MATH 440.

MATH 541. Topology II. 4 units
Term Typically Offered: SP
Prerequisite: MATH 440 or MATH 540.

Introduction to general topological spaces with emphasis on surfaces and manifolds. Fundamental group. Triangulations of spaces, classification of surfaces. Other topics may include covering spaces, simplicial homology, homotopy theory and topics from differential topology. 4 lectures. Not open to students with credit in MATH 441.

MATH 548. Transition to Graduate Mathematics. 4 units
Term Typically Offered: F
Prerequisite: Graduate standing.

Interactive construction and analysis of mathematical proof and exposition at the graduate level. Topics drawn from standard advanced material in real analysis, linear algebra, and modern algebra. Major credit limited to 4 units; total limited to 8 units. 2 lectures, 2 seminars.

MATH 550. Real Analysis. 4 units
Term Typically Offered: F
Prerequisite: Satisfactory completion of the Graduate Written Examination in Analysis or consent of the Graduate Committee.

Introduction to Lebesgue measure and integration, convergence theorems, Lp spaces, Radon-Nikodym Theorem and Fubini's Theorem. 4 lectures.

MATH 560. Field Theory. 4 units
Term Typically Offered: SP
Prerequisite: MATH 482 or graduate standing.

Polynomial rings, field extensions, normal and separable extensions, automorphisms of fields, fundamental theorem of Galois theory, and further topics such as solvable groups, solution by radicals, insolvability of the quintic. Not open to students with credit in MATH 483. 4 lectures.

MATH 561. Graduate Algebra. 4 units
Term Typically Offered: F
Prerequisite: Completion of the Graduate Written Exam in Algebra or consent of the Graduate Committee.

An introduction to advanced topics from modern algebra, including group actions, the Sylow theorems, semi-direct products, and modules over a principal ideal domain. Other topics may include commutative algebra, homological algebra, cryptography applications, and topics from advanced linear algebra. 4 lectures.

MATH 570. Selected Advanced Topics. 1-4 units
Term Typically Offered: TBD
Prerequisite: Graduate standing and consent of instructor.

Directed group study of selected topics for graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

MATH 580. Seminar. 1-4 units
Term Typically Offered: TBD
Prerequisite: Graduate standing and consent of instructor.

Built around topics in advanced mathematics chosen according to the common interests and needs of the students enrolled. Each seminar will have a subtitle according to the nature of the content. Total credit limited to 12 units. 1-4 seminars.

MATH 599. Thesis. 3 units
Term Typically Offered: F,W,SP,SU
Prerequisite: Graduate standing and consent of instructor.

Serious research endeavor devoted to the development, pedagogy or learning of mathematics. Total credit limited to 9 units.