139. General Oceanography. A study of the physical, chemical, biologic, and geologic aspects of the sea. An introduction to the 141 series of specialized marine science courses. Not open to students who have completed Geol. 105. Prerequisites; College Chemistry and Biology. (Lecture 3 hours; laboratory 3 hours.) Four units.

140. Geological Engineering Principles. A survey of geology applied to site investigation for dams, tunnels, and buildings. Prerequisites: Geol. 122, Math 30. (Lecture 3 hours, laboratory 3 hours.) Four units.

141. Geological Oceanography. A study of the structures, physiography and sediments of the sea bottom and shoreline. Prerequisite: Geol. 139 or consent of instructor. (Lecture 3 hours.) Three units.

143. Micropaleontology. A study of fossil micro-organisms with emphasis on stratigraphic and environmental significance of foraminifers. Prerequisite: Geol. 1B, or Geol. 2 and Zool. 1. (Lecture 2 hours; laboratory 3 hours.) Three units.

147. Applied Geophysics I. Introduction to gravimetric, magnetic, electromagnetic, and radioactive prospecting. Physical and geological principles, field techniques and case histories will be discussed. Prerequisites: Geol. 122. (Lecture 2 hours, laboratory 3 hours.) Three units.

148. Applied Geophysics II. Introduction to seismic and electrical prospecting. Physical and geological principles, field techniques and case histories will be discussed. The application of communication theory to geological problems will be investigated: including filter design and numerical studies of geological data. Prerequisite: Geol. 122. (Lecture 2 hours; laboratory 3 hours.) Three units.

180. Individual Studies. Advanced laboratory and field work. Limited to majors. One to three units by arrangement.

184. Directed Reading. Assigned readings of selected books, journals and special papers chosen with a view to filling the gaps in a student's training or to bring him into contact with new fields. Evaluation through weekly reports and conferences. One to three units by arrangement.

Graduate Courses

(See Graduate Catalog for details)

MATHEMATICS DEPARTMENT

Office: MacQuarrie Hall, Room 108

Professors ANDERSON, EDGAR, FELDMAN, FOWLER, GREER, HOGGATT, KRAMER, LANGE, LARSEN, LOVAGLIA, MARKS, MYERS, OLDS, POST, PRESTON, PRUITT, SMART, THORO, WREDE; Associate Professors BILLIK, BRADSHAW, DOLBY, FEINSTEIN, FITTING, FULLER (Chairman), HALTEMAN, MICHAEL, MITCHEM, SCHWEITZER, SILLS, STERN, SWANN, WEDDINGTON; Assistant Professors BURKE, BYRD, O'DONNELL, SIMONS

Baccalaureate Majors

Mathematics (B.A.)
Mathematics with Concentration in Statistics (B.A.)
Mathematics with Concentration in Computer Mathematics (B.A.)

Credential Program

Single Subject Instruction Credential (Secondary Education): Mathematics is an approved single-subject instructional area under the new Teacher Preparation and Licensing Act of 1970.

Master's Degree Majors

Mathematics (M.S.)
Mathematics (M.A.)

B.A. Degree With Major in Mathematics

	Semester Units
General Education	40
Physical Education	2
Requirements in the Major	37-41
Math. 30 (or 20), 31 (or 21), 32, 35 — 13-17	
Twenty-four (24) units in upper division mathematics, to include Math. 131A; Math. 112 or 115; Math. 128 or 129A; and not to include Math. 106, 107A, 107B and certain special courses, such as institute courses, not listed in this catalog.	
Supporting Courses Required	6-10
One year of college physics. On prior approval this may be replaced by 6 units of mathematics related courses from other departments.	
Electives	31-39
Total units required for degree	124*

B.A. in Mathematics With Concentration in Statistics

	Semester Units
General Education	40
Physical Education	2
Requirements for the Major	37-41
Math. 30 (or 20), 31 (or 21), 32, 35 — 13-17	
Twenty-four (24) units in upper division mathematics, to include Math. 131A; Math. 112 or 115; Math. 129A; Math. 163; Math. 164; together with 6 units from the following courses: Math. 144A-J (3 units); 165; 166. These courses may not include Math. 106, 107A, 107B and certain special courses such as institute courses not listed in this catalog.	

*40 of the 124 units for graduation must be upper division.

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Supporting Courses Required	6-10
One year of college physics. On prior approval this may be replaced by one year of mathematics related courses from other departments.	
Electives	31-39
Total units required for degree	124*

B.A. in Mathematics With Concentration in Computer Mathematics

	Semester Units
General Education	40
Physical Education	2
Requirements for the Major	37-41
Math. 30 (or 20), 31 (or 21), 32, 35	13-17
Twenty-four (24) units in upper division mathematics to include Math. 131A; Math. 112 or 115; Math. 129A; Math. 143; Math. 144A-J (3 units); Math. 163; Math. 179. These courses may not include Math. 106, 107A, 107B and certain special courses such as institute courses not listed in this catalog.	
Supporting Courses Required	6-10
One year of college physics. On prior approval this may be replaced by 6 units of mathematics related courses from other departments.	
Electives	31-39
(Engr. 150 and E.E. 174 are recommended)	
Total units required for degree	124*

MINOR IN MATHEMATICS

	Semester Units
For Baccalaureate Degrees	20
A total of 20 units of Math., including Math. 30 (or 20), 31 (or 21), 35	9
Eight units of upper division mathematics, including one semester of algebra and one semester of geometry	8
Three units of other mathematics electives, upper or lower division	3

The following courses may not be counted toward the minor in mathematics: Math. 12, 70, 106, 107A, 107B, and certain special courses, such as institute courses, not listed in this catalog.

HONORS PROGRAMS IN MATHEMATICS

The requirements for mathematics majors to graduate with departmental honors are: (1) at least a 3.0 G.P.A. overall, (2) at least a 3.5 G.P.A. in mathematics, and (3) completion of at least one Honors Seminar, and recommendation of that instructor.

The Department also may offer a lower division honors program extending over a period of four semesters.

Restriction on Enrollment for Credit

Enrollment for credit in Math. 5, 7, 8, 12, 70, 71, 106, and 107A, B will not be allowed for students who have received credit in Math. 29, 30, 31, or 32, unless the particular course in question must be taken in order to fulfill major, minor or credential requirements.

*40 of the 124 units for graduation must be upper division.

DESCRIPTION OF UNDERGRADUATE COURSES

Lower Division Courses

3. Slide Rule. Use of the slide rule in calculations involving multiplication, division, powers, roots, logarithms, trigonometric functions, solution of right and oblique triangles and exponential equations. Prerequisite: Trigonometry. One unit.

5. Introductory Algebra. Sets, numbers, and relations; open sentences in one and two variables; systems of two linear equations; polynomials, factors, and rational expressions; quadratic functions. Five units.

7. Intermediate Algebra. Brief review of Math. 5. Systems of equations, determinants; quadratic relations, complex numbers; exponents and logarithms; polynomial functions. Prerequisite: Math. 5. Three units.

8. Trigonometry. Trigonometric functions, solutions of triangles, graphs, functions of two angles, multiple-angle formulas and other identities; trigonometric equations, inverse trigonometric functions, complex numbers. Prerequisite: Two years of algebra and one year of geometry in high school, or Math. 7. Three units.

12. Number Systems I. Sets, the structure of the whole number, rational number, and real number systems; numeration systems, elementary number theory, and coordinates on a line. Prerequisite: One year of high school algebra and one year of high school geometry. Three units.

20. Analytic Geometry and Calculus I. The content of Math. 30 together with the first half of Math. 29. Prerequisite: Math. 8. Five units.

21. Analytic Geometry and Calculus II. The content of Math. 31 together with the second half of Math. 29. Prerequisite: Math. 30 or 20. Five units.

29. Analytic Geometry. Coordinate systems, the straight line and conic sections, higher plane curves, parametric equations, vector algebra, solid analytic geometry. Prerequisite: Math. 8. Four units.

30. Calculus I. An introductory course in calculus including differentiation, integration, applications, and vector calculus. Prerequisite: Math. 29. Three units.

31. Calculus II. Differentiation and integration of transcendental functions. Applications of the derivative and integral. Prerequisite: Math. 30 or 20. Three units.

32. Calculus III. Partial derivatives, multiple integrals, infinite series, and vector calculus. Prerequisite: Math. 31 or 21. Four units.

35. Introduction to Modern Algebra. Sets, functions, and relations. Properties of the integers including induction, well-ordering, unique factorization, and congruences. The rational numbers. Polynomials. An introduction to linear algebra and matrices. Prerequisite: Math. 29. Three units.

70. Finite Mathematics I. Systems of linear equations and inequalities, matrices, set theory, and probability theory. Applications to the behavioral and natural sciences. Prerequisite: 2 years of high school mathematics. Three units.

71. Finite Mathematics II. Applications of finite mathematics to the behavioral and natural sciences and an introduction to intuitive calculus. Prerequisite: 3 years of high school mathematics or Math. 70. Three units.

Upper Division Courses

104. History of Mathematics. Historical survey of mathematical development from earliest times to the 20th century. Prerequisite: Either Math. 128 and an upper division geometry course, or permission of the instructor. Three units.

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106. Intuitive Geometry. Basic ideas of metric and non-metric geometry including a study of measurement of lengths, angles, and regions, separations in a plane, congruence, parallelism, and similarity. An introduction to logic, proof, and graphing of functions and other relations. Prerequisite: Math. 12 or equivalent. Three units.

107A. The Structure of Elementary Algebra. An axiomatic study of the real numbers as a complete ordered field. The complex number field. The role of sets in the solution of open sentences. The function concept as a unifying element in elementary algebra. Prerequisite: Math. 106 or equivalent. Three units.

107B. The Structure of Elementary Geometry. Concepts of betweenness, separation in the plane, congruence, measures, parallelism, and similarity. The nature of deductive proof and a continuation of the study of coordinate geometry. Prerequisite: Math. 106 or equivalent. Three units.

108. Problem Solving in Mathematics. A study of general ideas useful in solving mathematical problems; generalization, specialization, analogy, induction, recursion, and others. Practice in applying these ideas to a variety of non-routine problems. Prerequisite: at least one mathematics course numbered above 110. Two units.

112. Vector Analysis and Euclidean Geometry. Algebra and calculus of vectors; metric structure of Euclidean space; transformations, vector fields, integration and applications; introduction to Cartesian tensors. Prerequisite: Math. 32. Three units.

113. Differential Geometry. Properties of curves and surfaces, Frenet-Serret formulas and the fundamental forms. The study of curves and surfaces in the small by means of differential calculus. Prerequisite: Math. 112. Three units.

115. Modern Geometry and Transformations. Synthetic and analytic theory of projective transformations, similarities, Euclidean motions; inversive geometry. Prerequisite: Math. 32. Three units.

116. Special Topics in Modern Geometry. Axiomatic systems for Euclidean, non-Euclidean, and finite geometries. Convexity and selected topics from modern synthetic geometry. Prerequisite: Math. 112 or Math. 115. Three units.

128. Algebraic Structures. Groups, rings, and fields, their structures and morphisms, including quotient groups, transformation groups, ideals, quotient rings, integral domains, field extensions. Prerequisite: Math. 35 and Math 31 (or 21). Three units.

129A. Linear Algebra I. Matrices, systems of linear equations, vector spaces, vector geometry, linear transformations. Prerequisites: Math. 35 and Math. 31 (or 21). Three units.

129B. Linear Algebra II. Continuation of Math. 129A. Linear transformations and matrices. Eigenvectors and eigenvalues. Decomposition of matrices. Inner product spaces. Applications. Prerequisite: Math. 129A. Three units.

131A. Introduction to Analysis. Properties of the real numbers including completeness and compactness. Continuous functions. Uniform continuity. The derivative. Prerequisite: Math. 32. Three units.

131B. Introduction to Real Variables. The theory of the Riemann integral. Sequences and series of functions. Spaces of functions. Prerequisite: Math. 131A. Three units.

133. Differential Equations. A course in ordinary differential equations; numerical solutions; introduction to Fourier series. Prerequisite: Math. 32. Three units.

134. Advanced Calculus. Limits, continuity, and partial differentiation of functions of several variables. Implicit function theorems. Line and surface integrals and volume. Emphasis throughout will be on 2 and 3 variables. Prerequisite: Math. 32. Three units.

135. Calculus of Several Variables. Euclidean n-space, functions, differentiation and integration. Multilinear algebra and differential forms. The calculus on Manifolds and Stokes' Theorem. Prerequisite: Math. 129A, 112 or 134. Three units.

141. Boundary Value Problems. Partial differential equations of physics and engineering. Legendre polynomials, Bessel functions, orthogonal functions. The Sturm-Liouville equation. Prerequisite: Math. 133. Three units.

143. Numerical Analysis. Differences; interpolation formulas; numerical differentiation and integration; numerical methods for solving differential and integral equations. Prerequisite: Math. 133. Three units.

144A-J. Programming Techniques and Analysis. Each unit gives one-third of a semester of problem solving on one of the topics: A. Fortran IV programming; B. Monte Carlo methods; C. Numerical solution of differential equations; D. Assembly language programming; E. Statistical information processing; F. Iterative matrix techniques; G. Number theory; H. Non-numerical techniques; I. Error Analysis; J. Fourier approximation. A total of 6 units may apply toward a degree. Math. 144A (Fortran IV programming) or equivalent to precede other units. Prerequisite: Math. 32 or consent of instructor. One unit each.

148. Complex Variable. Analytic functions, complex integration, residues, and power series. Prerequisite: Math. 32. Three units.

151. Theory of Numbers I. Divisibility, prime numbers, congruences of first and higher degress, theorems of Fermat, Euler, and Wilson, quadratic residues. Prerequisites: Math. 35 and Math. 31 (or 21). Three units.

163. Introduction to Probability and Statistics. Probability axioms—Discrete case. Probability laws, permutations, combinations, partitions. Marginal and conditional probability—Bayes' Theorem. Binomial, Poisson probability laws. Probability axioms—continuous case. Random variables, density and distribution functions, marginal and conditional functions. Uniform and normal probability laws. Mathematical expectation. Limit theorems. Prerequisite: Math. 32. Three units.

164. Mathematical Statistics. t and F distributions. Other sampling distributions. Distributions of sample means and variances. Interval estimation. Confidence intervals for mean and variances. Order Statistics, tolerance limits. Sufficient statistics. The Rao-Blackwell Theorem. Completeness, uniqueness. Point estimation. Maximum likelihood, Bayes' methods. Testing hypotheses. Prerequisite: Math. 163. Three units.

165. Probability Theory. Advanced combinatorial problems, occupancy, matching, etc. Independent trials. Bernoulli trials. Dependent trials, Markov dependent trials, Markov dependent Bernoulli trials. Markov chains. Random walks. Classification of states. Recurrence and renewal. Queueing theory. Continuous Markov chains, Kolmogorov equations. Poisson processes. Birth and death processes. Prerequisite: Math. 163. Three units.

166. Applied Statistics. Probability distributions; acceptance sampling; hypothesis testing; estimation of extreme values, rejection of data; linear, non-linear curve fitting; regression; polynominal models; analysis of variance; non-parametric procedures; discrimination and recognition. Prerequisite: Math. 163 or permission of instructor. Three units.

171. Foundations of Mathematics. Fundamental and unifying principles of logic, algebra and geometry with emphasis on the nature of proof and the axiomatic approach. Prerequisite: One semester each of upper division algebra and geometry. Three units.

175. Introduction to Topology. Set theory. Topological spaces and separation axioms. Completeness, compactness, and connectedness. Functions and continuity. Product spaces. Prerequisite: Math. 131A. Three units.

179. Introduction to Graph Theory. Hamiltonian and Eulerian properties of graphs. Trees, connectivity, graph valued functions. Coloring problems and planarity. Ramsey number, the Ulam-Kelly conjecture. Prerequisite: Math. 128 or 129A or permission of instructor. Three units.

180. Individual Studies. Individual study in a specific field. Registration to be approved by department chairman. One to four units.

195. Honors Seminar. Subject matter is determined by the instructor and the departmental honors committee. At least one Honors Seminar is required for graduation with honors in mathematics. Prerequisite: Junior standing and consent of instructor. Three units.

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Mathematics Education

MthEd. 184F Secondary School Student Teaching. (See Education Section for description.) Four units.

MthEd. 184Y. Student Teaching III – Classroom Teaching. Prerequisite: Joint approval of major and education departments. Minimum 80–120 class periods of classroom teaching, laboratory or field teaching in appropriate single subjects, grades K-12, and related teaching activities and seminar. Four to six units.

MthEd. 184Z. Student Teaching IV – Classroom Teaching. (Same as 184Y, but may be in different subject, or in a different school, and will be at a different grade level.) Four to six units.

MthEd. 394. Secondary School Mathematics. Basic course in teaching of secondary mathematics. The place and function of mathematics in secondary education, the improvement and evaluation of instruction, and the teaching of the subject matter of secondary mathematics. Two units.

Graduate Courses

(See Graduate Catalog for details)