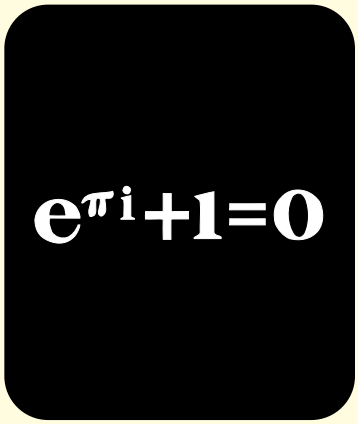
MATHEMATICS AND STATISTICS



BACHELOR OF ARTS
SUBJECT MATTER PROGRAM
MINOR
MASTER OF ARTS

PROGRAM DESCRIPTION

In today's highly technological society, the study of Mathematics takes on an increasingly important role. The CSUS Mathematics Department designs its courses with a goal of providing students with the mathematical concepts appropriate to the student's field.

The program consists of sequences of courses which lead to 1) a Bachelor of Arts with a major in Mathematics, a major in Mathematics with emphasis in Applied Mathematics and Statistics, a minor in Mathematics or Statistics, and 2) a Master of Arts in Mathematics.

In cooperation with the Computer Science Department, a BA double major program in mathematics and computer science is offered.

FEATURES

The study of mathematics at CSUS has several strong advantages. The flexibility of the major gives students enough freedom to mold their degree along their particular interest. An excellent computer facility gives mathematics students easy access to the campus computer resources. Currently there is a demand for majors in mathematics with training in Applied Mathematics and Statistics. Our graduates have had much success in finding employment in public and private sectors. In addition, since there is presently a need for high school mathematics teachers, some of our majors pursue a secondary teaching career. Graduate students in mathematics are finding opportunities for public and private employment in jobs requiring more advanced training in Mathematics and Statistics. There are a number of our Masters Degree graduates now teaching at community colleges throughout the state. Upper division majors may check with the Mathematics Department Secretary on the possibility of applying for paid positions as Student Assistants. Student Assistants work from 10-20 hours per week in math-related duties on campus.

Students interested in majoring or minoring in Mathematics should contact the Department Secretary for an advising appointment with a Mathematics Advisor.

FACULTY

Edward Bradley, *Chair*

Elaine Alexander; J. Michael Bossert; Edward Bradley; Richard Cleveland; Elizabeth Ebrahimzadeh; Roland Esquerra; Robert Etter; Wallace Etterbeek; Scott Farrand; Lloyd Gavin; James Gehrmann; Peter Griffin; Charles Hagopian; Howard Hamilton; John Ingram; Robert Jaffa; Earl Kymala; Roger Leezer; Marcus Marsh; K. C. Ng; Doraiswamy Ramachandran; Geetha Ramachandran; Thomas Schulte; Armand Seri; Gary Shannon; Ed Shea; Donald Taranto; Lisa Taylor; Kecheng Zhou

Department Office, Math/History 141, 278-6534

CAREER POSSIBILITIES

Mathematics • Teacher • Numerical Analyst • Engineering Analyst • Systems Analyst • Operations Analyst • Actuary • Casualty Rater • Technical Writer • Types of Statisticians: Survey/Polling. Biological/ Agricultural, Business/Economics, Physical Sciences/ Engineering

MAJOR REQUIREMENTS • BA

Total units required for BA: 124
Total units required for Major: 47-51
Courses in parentheses are prerequisites.

A. Lower Division Core Courses (20-21 units)

(4) MATH 30 Calculus I (MATH 29)
(4) MATH 31 Calculus II (MATH 30 or appropriate high school AP credit)
(4) MATH 32 Calculus III (MATH 31)
(3) MATH 35 Introduction to Linear Algebra (MATH 30 or appropriate high school AP credit)
(3) MATH 45 Differential Equations for Science and Engineering (MATH 31)
(2-3) Select one of the following:
CSC 15 Programming Concepts & Methodology I (CSC 1 or 1A)
CSC 16 FORTRAN Programming (intermediate algebra)

B. Upper Division Core Courses (15 units)

(3) MATH 108 Introduction to Formal Mathematics (MATH 31, 35)
(3) MATH 110A Modern Algebra (MATH 108)
(3) MATH 110B Modern Algebra (MATH 110A)
(3) MATH 130A Functions of a Real Variable (MATH 32, 45, 108)
(3) MATH 130B Functions of a Real Variable (MATH 130A)

C. Area Requirements (12-15 units)

Select one numbered area below:

1. Pure Mathematics (12 units)

(3) MATH 117 Linear Algebra (MATH 110A)
(3) MATH 134 Functions of a Complex Variable and Applications (MATH 32)
(6) Six units of upper division Mathematics or Statistics relating to the students academic and professional objectives; consult advisor.

2. Applied Mathematics and Statistics (12 units)

(3) STAT 115A Introduction to Probability Theory (MATH 31)
(3) STAT 115B Introduction to Mathematical Statistics (STAT 115A)
(6) Select two of the following:
MATH 104 Vector Analysis (MATH 32)
MATH 105A Advanced Mathematics for Science and Engineering I (MATH 32, 45)
MATH 105B Advanced Mathematics for Science and Engineering II (MATH 105A)
MATH 117 Linear Algebra (MATH 110A)
MATH 134 Functions of a Complex Variable and Applications (MATH 32)
MATH 150 Introduction to Numerical Analysis (MATH 32 or 45)
MATH 170 Linear Programming (MATH 31; MATH 35 or 100)
STAT 155 Introduction to Techniques of Operations Research (MATH 31; STAT 50, 103, or 115A)

3. Teaching Credential Program (15 units)

(3) MATH 102 Number Theory (MATH 31)
(3) MATH 121 College Geometry (MATH 31; MATH 32 or 35)
(3) MATH 190 History of Mathematics (MATH 31)
(3) MATH 193 Capstone Course for Teaching Credential Candidate (five of: MATH 102, 110A, 110B, 121, 130A, 130B, or 190; concurrent enrollment in MATH 110A or 130A permitted)
(3) STAT 1 Introduction to Statistics

Notes:

- Prerequisites must be completed with grade "C-" or better.
- Grade "C-" or better required in all courses applied to a Mathematics major, or the Mathematics or Statistics minors.
- PHYS 11A and 11C recommended for all Mathematics majors.

SUBJECT MATTER PROGRAM (Pre-Credential Preparation)

Students interested in a Secondary Teaching Credential should select **Area 3** in **Section C** in the BA requirements outlined above.

Teaching credential candidates must also complete the Professional Education Program in addition to other requirements for a teaching credential. Consult the department credential advisor for details. You may also obtain information about the Professional Education Program from the Education Student Service Center (Education Building Room 216, 278-6174).

DOUBLE MAJOR • MATHEMATICS AND COMPUTER SCIENCE

Total units required for BA: 124
Total units required for Double Major: 77
Courses in parentheses are prerequisites.

A. Lower Division Courses (27 units)

1. Mathematics/Statistics (18 units)

(4) MATH 30 Calculus I (MATH 29)
(4) MATH 31 Calculus II (MATH 30)
(4) MATH 32 Calculus III (MATH 31)
(3) MATH 35 Introduction to Linear Algebra (MATH 30)
(3) MATH 45 Differential Equations for Science and Engineering (MATH 31)

2. Computer Science (9 units)

(3) CSC 15 Programming for the Computing Sciences (CSC 1 or placement test)
(3) CSC 20 Programming Concepts and Methodology II (CSC 15)
(3) CSC 35 Assembly Language Programming (CSC 15)

B. Upper Division Courses (50 units)

1. Mathematics/Statistics (21 units)

(3) MATH 108 Introduction to Formal Mathematics (MATH 31, 35)
(3) MATH 110A Modern Algebra (MATH 108)
(3) MATH 130A Functions of a Real Variable (MATH 32, 45, 108) **OR**
MATH 134 Functions of a Complex Variable and Applications (MATH 32)
(3) STAT 115A Introduction to Probability Theory (MATH 31)
(3) STAT 115B Introduction to Mathematical Statistics (STAT 115A)

(6) Select two of the following:
- MATH 150 Introduction to Numerical Analysis (MATH 32 or 45)
- MATH 170 Linear Programming (MATH 31, 35)
- STAT 155 Introduction to Techniques of Operations Research (MATH 31; STAT 50, 103, or 115A)

2. Computer Science (29 units)

(3) CSC 130 Data Structures and Algorithm Analysis (CSC 20)
(3) CSC 131 Computer Software for Engineering (CSC 130)
(3) CSC 134 File Organization for Data Management (CSC 35 or 35A, 130)
(3) CSC 135 Systems Programming (CSC 35 or 35A, 130)
(3) CSC 136 Programming Languages (CSC 130)
(4) CSC 137 Computer Organization (CSC 35 or 35A, 130)
(3) CSC 139 Operating System Principles (CSC 135)
(3) CSC 148* System Simulation (STAT 50)
(2) CSC 190 Senior Project: Part I (senior standing, Writing Proficiency Exam, CSC 131)
(2) CSC 191 Senior Project: Part II (CSC 190)

* CSC 132 Computing Theory may be taken in lieu of CSC 148 with department approval.

MINOR REQUIREMENTS

Mathematics

The Mathematics Minor requires a minimum of 20 units all of which must be taken in Mathematics or Statistics. A minimum of 8 upper division units is required. At least six upper division units must be taken at CSUS. Specific requirements are:

1. Option I (20-21 units)

(4) MATH 30 Calculus I (MATH 29)
(4) MATH 31 Calculus II (MATH 30)
(3-4) Select one of the following:
- MATH 32 Calculus III (MATH 31)
- MATH 35 Introduction to Linear Algebra (MATH 30)
- STAT 50 Introduction to Probability and Statistics (MATH 30)

(9) Select nine units of upper division Mathematics and/or Statistics courses selected with approval of a Mathematics advisor.

2. Option II (20 units)

(4) MATH 30 Calculus I (MATH 29)
(4) MATH 31 Calculus II (MATH 30)
(4) MATH 32 Calculus III (MATH 31)
(4) MATH 105A Advanced Mathematics for Science and Engineering (MATH 32, 45)
(4) MATH 105B Advanced Mathematics for Science and Engineering (MATH 105A)

Statistics

The Statistics Minor requires a minimum of 18 units all of which must be taken in Mathematics or Statistics. A minimum of six upper division units is required. At least six upper division units must be taken at CSUS. Specific requirements are:

(4) MATH 30 Calculus I (MATH 29)
(4) MATH 31 Calculus II (MATH 30)
(4) MATH 32 Calculus III (MATH 31) **OR**
STAT 50 Introduction to Probability and Statistics (MATH 30)
(3) STAT 115A Introduction to Probability Theory (MATH 31)
(3) STAT 115B Introduction to Mathematical Statistics (STAT 115A)

GRADUATE PROGRAM

The Department of Mathematics and Statistics offers a Master of Arts degree in mathematics. The MA program is designed to provide qualified students with an opportunity to increase the breadth and depth of their mathematical knowledge and understanding. Beyond assuring that successful candidates are proficient in the basic areas of mathematics, the program is sufficiently flexible to permit graduates to pursue individual professional and mathematical interests ranging from teaching at the secondary or community college level to a career in the private sector, to preparation for graduate study beyond the master's degree. Graduate courses are usually offered in the late afternoon and early evening to accommodate students who work full-time.

Admission Requirements

Admission as a classified graduate student in Mathematics requires:

- an undergraduate major in Mathematics which includes one year each of Abstract Algebra and Advanced Calculus or an undergraduate major in a related field together with one year each of Modern Algebra and Advanced Calculus, **and**
- a minimum 2.5 GPA, **and**
- a minimum 2.5 GPA in the last 60 units attempted and a 3.0 GPA in Mathematics coursework

Students who have deficiencies in Admission Requirements that can be removed by specified additional preparation may be admitted with conditionally classified graduate status. Any such deficiencies will be noted on a written response to the admission application. No credit will be given towards the MA for MATH 110A, 110B, 130A, or 130B.

Admission Procedures

Applications are accepted as long as room for new students exists. However, students are strongly urged to apply by April 1 for the following Fall or October 1 for the following Spring in order to allow time for admission before Computer Access Student Phone Entry Registration. All prospective graduate students, including CSUS graduates, must file the following with the Graduate Center:

- an application for admission and a supplemental application for graduate admission (Forms A and B in the CSU application booklet)
- two sets of official transcripts from all colleges and universities attended, *other than CSUS*

Approximately six weeks after receipt of all items listed, an admission decision will be mailed to the applicant.

Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the classified graduate student has:

- removed any deficiencies in Admission Requirements **and**
- completed at least 18 units in the graduate program with a minimum 3.0 GPA, including at least 12 units at the 200 level.

Advancement to Candidacy forms are available in the Graduate Center. The student fills out the form after planning a degree program in consultation with a Mathematics advisor. The completed form is then returned to the Graduate Center for approval.

Degree Requirements

The Master of Arts in Mathematics requires completion of 30 units of coursework, including at least 24 units of approved 200-level courses, with a minimum 3.0 GPA.

A. Required Courses (30 units)

(3) MATH 210A* Algebraic Structures (MATH 110B)
(3) MATH 210B* Algebraic Structures (MATH 210A)
(3) MATH 230A* Real Analysis (MATH 130B)
(3) MATH 230B* Real Analysis (MATH 230A)
(12) Select two of the following A/B combinations with graduate advisor approval:
MATH 220A Topology (MATH 130B) **AND**
MATH 220B Topology (MATH 110A, 220A)
MATH 234A Complex Analysis (MATH 130B) **AND**
MATH 234B Complex Analysis (MATH 130B)
MATH 241A Methods of Applied Math (MATH 105A recommended) **AND**
MATH 241B Methods of Applied Math (MATH 241A)
STAT 215A Advanced Math Statistics (STAT 115A, 115B) **AND**
STAT 215B Advanced Math Statistics (STAT 115A, 115B)
(6) Select one of the following with advisor approval:
MATH 296 Advanced Topic Seminars
MATH 299 Special Problems
Electives in mathematics and related disciplines

*Courses must be completed with grade ''B-'' or better.

B. Culminating Requirement

Written Comprehensive Examination

Foreign Language

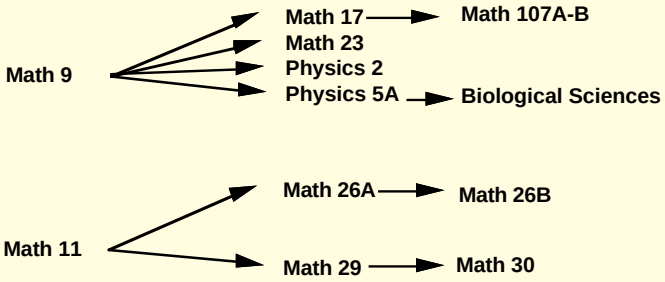
A foreign language is not required for the MA degree. However, students who plan further graduate study are encouraged to take coursework in French, German, or Russian since proficiency in two of these languages is usually required in doctoral programs.

PLACEMENT IN MATHEMATICS COURSES

Students who have not completed 4 years of high school mathematics consisting of:

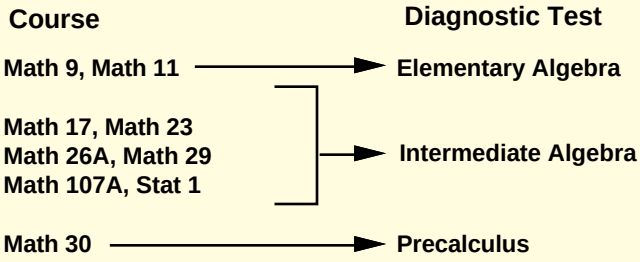
a. Beginning Algebra (1 year)
b. Geometry (1 year)
c. Intermediate Algebra-Trigonometry (1 year)
d. Analytic Geometry-Mathematical Analysis (1 year)

may need to complete part of this preparation at the University. The following diagram, which is based upon course prerequisites and major objectives, may be of assistance in selecting the necessary coursework.



Satisfactory completion of the Entry Level Mathematics (ELM) requirement is a prerequisite to enrollment in any mathematics or statistics course in Group IIA (Quantitative Reasoning) of General Education. The mathematics and statistics courses listed in Group IIA are: MATH 1, 17, 23, 26A, 26B, 29, 30, 31, 35, STAT 1, and 50.

Students Planning to take any of the following courses: MATH 9, 11, 17, 23, 26A, 29, 30, 107A, or STAT 1 must pass a diagnostic test. A brochure describing the diagnostic tests and containing sample questions is available in the campus bookstore. The following table gives the course and appropriate diagnostic test.



Those students who want to prepare for the ELM or the Elementary Algebra Diagnostic Test may purchase the Entry Level Mathematics workbook at the Hornet Bookstore (see the Learning Skills section of catalog).

All students planning to take MATH 30, Calculus I, must take the pre-calculus diagnostic test prior to the semester of enrollment in MATH 30. Arrangements should be made with the CSUS Testing Center (916) 278-6296.

LOWER DIVISION COURSES

Mathematics

Note: Prerequisites must be completed with a grade of ''C-'' or better.

1. Mathematical Reasoning. Course is recommended for students whose majors do not include a specific mathematics requirement. The course objectives are to show some of the essence and quality of mathematics, and to enhance precision in the evaluation and expression of ideas, thereby developing a student's quantitative reasoning skills. The course is designed to give students an understanding of some of the vocabulary, methods, and reasoning of mathematics with a focus on ideas. **Prerequisites:** MATH 9 or three years of high school mathematics which includes two years of algebra and one year of geometry; and completion of ELM requirement. 3 units. (CAN MATH 2)

9. Essentials of Algebra and Trigonometry. Prepares students, especially in bioscience, economics and social science, for courses requiring basic algebra and trigonometry. Topics: measurement and scientific notation; review of basic algebra; factoring; laws of exponents; linear and quadratic equations; cartesian coordinates and graphing; the trigonometric functions and their basic identities; solutions of right triangles; the laws of sines, cosines and tangents; solutions of general triangles; logarithms. **Note:** course is applicable to workload credit for establishing full-time enrollment status, but not applicable to the baccalaureate degree. **Prerequisites:** one year each of high school algebra and geometry; and a passing score on the Elementary Algebra diagnostic test. Graded Credit/No Credit. 3 units.

11. College Algebra. Prepares students for MATH 29 and other courses requiring college algebra. Topics: solution of polynomial equations; synthetic division; factoring; partial fractions; inequalities; determinants; mathematical induction and the binomial theorem. **Note:** course is applicable to workload credit for establishing full-time enrollment status, but not applicable to the baccalaureate degree. **Prerequisites:** one year each of high school algebra and geometry; and a passing score on the Elementary Algebra diagnostic test. Graded Credit/No Credit. 4 units

17. An Introduction to Exploration, Conjecture, and Proof in Mathematics. Prepares students for MATH 107A and 107B. Students will explore mathematical patterns and relations, formulate conjectures, and prove their conjectures. Topics from number theory, probability and statistics, and geometry. **Prerequisites:** MATH 9 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra diagnostic test. 3 units.

23. Business Calculus. Review of logarithmic and exponential functions, intuitive introduction to limits, development of the derivative, definite integral, and partial derivatives. Application of these concepts to economics and business will be emphasized. **Prerequisites:** MATH 9 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra diagnostic test. 3 units. (CAN MATH 34)

26A. Calculus I for the Social and Life Sciences. Limits, differentiation with applications, integration and applications in the Social Sciences and Life Sciences. **Prerequisites:** MATH 11 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra diagnostic test. 3 units. (CAN MATH 30)

26B. Calculus II for the Social and Life Sciences. Continuation of MATH 26A, integration and applications to the Social Sciences and Life Sciences. Multi-variate analysis including partial differentiation and maximization subject to constraints; elementary differential equations; sequences and series. Calculus of the trigonometric functions as time allows. Students will be given periodic writing assignments which encourage them to think through concepts of the course. **Note:** not open to students already having credit for MATH 31 or equivalent. **Prerequisite:** MATH 26A or appropriate high school based AP credit. 3 units. (CAN MATH 32)

29. Pre-Calculus Mathematics. This course is designed to prepare students for calculus. Topics: trigonometry, points and lines in the cartesian plane; lines and planes in space; transformation of coordinates; the conics; graphs of algebraic relations; the elementary transcendental functions. **Prerequisites:** MATH 11 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and Intermediate Algebra diagnostic test. 4 units. (CAN MATH 16)

29A. Pre-Calculus Mathematics A. This is the first semester course that is designed to prepare students for calculus. Topics: functions and graphs, polynomial functions, rational functions applications. Lecture two hours. **Prerequisites:** MATH 11 or three years of high school mathematics that includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra Diagnostic Test. **Corequisite:** MATH 29L. 2 units.

29B. Pre-Calculus Mathematics B. This is the second semester of a two semester course that is designed to prepare students for calculus. Topics: exponential and logarithmic functions, trigonometric functions, analytic geometry, and applications. Lecture two hours. **Prerequisite:** MATH 29A. **Corequisite:** MATH 29M. 2 units.

29L. Lab for Pre-Calculus Math A. A workshop designed to deepen the understanding of pre-calculus developed in MATH 29A. **Note:** this course may be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree. Laboratory three hours. **Corequisite:** MATH 29B. Graded Credit/No Credit. 1 unit.

29M. Lab for Pre-Calculus Math B. A workshop designed to deepen the understanding of pre-calculus developed in MATH 29B. **Note:** this course may be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree. Laboratory three hours. **Corequisite:** MATH 29B. Graded Credit/No Credit. 1 unit.

30. Calculus I. Functions and their graphs; limits; the derivative and some of its applications; the integral; the fundamental theorem; some applications of the integral. **Prerequisites:** MATH 29 or four years of high school mathematics which includes two years of algebra, one year of geometry, and one year of mathematical analysis; completion of ELM requirement and Pre-Calculus diagnostic test. 4 units. (CAN MATH 18)

31. Calculus II. MATH 30 continuation. Methods of integration; improper integrals; trigonometric and hyperbolic functions and their inverses; analytic geometry; infinite sequences and series. Students will be given periodic writing assignments which encourage them to think through concepts of the course. **Prerequisite:** MATH 30 or appropriate high school based AP credit. 4 units. (CAN MATH 20)

32. Calculus III. Continuation of Calculus II. Algebra and calculus of vectors; functions of several variables; partial differentiation; multiple integration; vector analysis. **Prerequisite:** MATH 31. 4 units. (CAN MATH 22)

35. Introduction to Linear Algebra. Careful development of matrices, systems of equations, determinants, vector spaces, linear transformations, orthogonality, real and complex eigenvalues; R^3 viewed as a vector space with generalization to R^n. Students will be given periodic writing assignments which encourage them to think through concepts of the course. **Prerequisite:** MATH 30 or appropriate high school based AP credit. 3 units. (CAN MATH 26)

45. Differential Equations for Science and Engineering. First order differential equations, second order differential equations with constant coefficients. Laplace transforms, small systems of linear differential equations, numerical methods, introduction to second order differential equations with variable coefficients. **Prerequisite:** MATH 31. 3 units. (CAN MATH 24)

96. Experimental Offerings in Mathematics. With demand from a sufficient number of qualified students, one of the staff will conduct a seminar on some topic in mathematics. 1-6 units.

99. Special Problems. Individual projects or directed reading. **Note:** open only to students who appear competent to carry on individual work; admission requires the approval of the faculty member under whom individual work is to be conducted, and approval of the advisor and the department chair. 1-6 units.

Statistics

Note: Prerequisites must be completed with a grade of ''C-'' or better.

1. Introduction to Statistics. Descriptive statistics, basic concepts of probability and sampling with the aim of introducing fundamental notions and techniques of statistical inference. **Prerequisites:** MATH 9 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra diagnostic test. 3 units. (CAN STAT 2)

50. Introduction to Probability and Statistics. Sample spaces, combinatorics, and random variables. Density and distribution functions. Expectation, variance, and covariance. The binomial, uniform, poisson, negative binomial, hypergeometric, exponential, and normal distributions. Sampling distributions, estimation, and hypothesis tests. Students given periodic writing assignments which encourage them to think through concepts of the course. **Prerequisite:** MATH 26A, 30, or appropriate high school based AP credit. 4 units.

96. Experimental Offerings in Statistics. When there is a demand from a sufficient number of qualified students, one of the staff will conduct a seminar on some topic in statistics. 1-6 units.

UPPER DIVISION COURSES

Mathematics

Note: Prerequisites must be completed with a grade of ''C-'' or better.

100. Applied Linear Algebra. A course in linear algebra and its elementary applications. Topics: Matrix algebra; simultaneous linear equations; linear dependence and vector spaces; rank and inverses; determinants; numerical solution of simultaneous linear equations; linear transformations; eigenvalues and eigenvectors; unitary and similarity transformations; quadratic forms. **Note:** may not be taken for credit toward a mathematics major. **Prerequisite:** MATH 26B or 31. 3 units.

101. Discrete Mathematics. Elementary set theory, elementary logic, predicates and quantifiers, methods of proof, functions and relations, recursive definitions and recurrence relations, counting techniques, introduction to graphs and trees, and introduction to Boolean functions. **Note:** may not be taken for credit toward a mathematics major. **Prerequisite:** MATH 26B or 31. 3 units.

102. Number Theory. The theory of divisibility; some number theoretical functions; congruencies (linear and quadratic); some Diophantine equations. Simple continued fractions. **Prerequisite:** MATH 31. Spring only. 3 units.

104. Vector Analysis. Vector and scalar fields, integral theorems, orthogonal curvilinear coordinates, vector spaces and linear transformations, applications to physical fields and operators. **Prerequisite:** MATH 32. Spring only. 3 units.

105A. Advanced Mathematics for Science and Engineering I. Survey of 2nd order linear differential equations, power series and Fourier series solutions, solution of partial differential equations by separation of variables. **Prerequisite:** MATH 32, 45. 4 units.

105B. Advanced Mathematics for Science and Engineering II. Partial differential equations continued, complex function theory and its applications. **Prerequisite:** MATH 105A. 4 units.

107A. Fundamental Mathematical Concepts. The first half of a one-year course in the structure of the real number system and its sub-systems and in the basic properties and concepts of geometry. Topics will include: definitions and properties of set theory and their use in the development of the natural and whole number systems, definitions and properties of the arithmetic relations and operations for the natural numbers, whole numbers, integers. **Note:** may not be taken for credit toward a mathematics major or minor. **Prerequisites:** MATH 17 and passing score on the Intermediate Algebra diagnostic test. 3 units.

107B. Fundamental Mathematical Concepts. A continuation of MATH 107A. Topics will include: rational numbers, real numbers, measurement, Euclidean Geometry. **Note:** May not be taken for credit toward a mathematics major or minor. **Prerequisites:** MATH 107A. 3 units.

108. Introduction to Formal Mathematics. Logic of mathematical proof, set theory, relations, functions. Examples and applications from set cardinality, algebra, and analysis. **Prerequisites:** MATH 31, 35. 3 units.

110A. Modern Algebra. The first half of a one-year introductory course in algebraic concepts. Topics include: groups, subgroups, properties of groups, permutation groups, factor groups, homomorphism theorems. **Prerequisites:** MATH 108. 3 units

110B. Modern Algebra. A continuation of MATH 110A. Topics include: rings and fields. Applications may be selected from lattice, machine, and coding theories. **Prerequisites:** MATH 110A. 3 units

117. Linear Algebra. Abstract linear spaces and linear transformations; invariant subspaces; canonical forms. **Prerequisite:** MATH 110A. Fall only. 3 units.

121. College Geometry. Theorems and proofs in Euclidean geometry with emphasis on student exposition. Euclidean constructions, loci, inversion, and Euclidean geometry in three dimensions. Concentrates on problems whose solutions demonstrate the underlying unity of Euclidean geometry, algebra, analytical geometry and calculus. **Prerequisites:** MATH 31; 32 or 35. Fall only. 3 units.

122. Euclidean and Non-Euclidean Geometries. A study of the axioms and theorems of Euclidean geometry. A comparison of several geometric axiom systems and their theorems, including those of some non-Euclidean and finite geometries. **Prerequisite:** MATH 108 or 121. Spring only. 3 units.

130A. Functions of a Real Variable. The first half of a one-year upper division course in functions of a real variable. The first semester will consist of a rigorous development of the theory of real-valued sequences and continuity and differentiation for functions of one real variable. **Prerequisites:** MATH 32, 45, 108. 3 units.

130B. Functions of a Real Variable. A continuation of MATH 130A. This semester will be devoted to a rigorous development of the theory of Riemann integration, infinite series, and sequences and series of functions. **Prerequisites:** MATH 130A. 3 units.

134. Functions of a Complex Variable and Applications. The complex plane; analytic functions; integration and Cauchy's Theorem; sequences and series; residue calculus; applications to potential theory; Fourier and Laplace transforms. **Prerequisite:** MATH 32. 3 units.

150. Introduction to Numerical Analysis. Finite differences and applications; interpolations, inverse interpolations; numerical differentiation and integration; inversion of matrices; numerical methods of solution of linear equations; algebraic and transcendental equations; numerical methods of solving ordinary and partial differential equations. **Prerequisite:** MATH 32 or 45; some computer programming experience is desirable. 3 units.

161. Mathematical Logic. Advanced study of logic with special application to mathematics. **Prerequisite:** MATH 108. Fall only. 3 units.

162. Set Theory. An axiomatic study of set theory. Topics usually considered include: relations and functions; set theoretical equivalence; finite and infinite sets; cardinal arithmetic; ordinal numbers and transfinite induction; variants of the Axiom of Choice. **Prerequisite:** MATH 108. Spring only. 3 units.

170. Linear Programming. Theory of linear programming, duality, simplex method, integer programming, applications. **Prerequisites:** MATH 31; MATH 35 or 100. Fall only. 3 units.

190. History of Mathematics. A study of the development of mathematical ideas and techniques and their impact on the general course of the history of western civilization. **Prerequisites:** MATH 31 and upper division standing in mathematics. Spring only. 3 units.

193. Capstone Course for the Teaching Credential Candidate. Reviews the major themes presented in the upper division program in Mathematics, and relates the themes to junior high school and high school curriculum. Required for all subject matter students. **Note:** not accepted for credit for non-Teaching Credential students. **Prerequisites:** successful completion of at least five of the following: MATH 102, 110A, 110B, 121, 130A, 130B or 190; MATH 110A or 130A may be taken concurrently. Spring only. 3 units.

196. Experimental Offerings in Mathematics. Given demand from a sufficient number of qualified students, one of the staff will conduct a seminar on some topic in mathematics. 1-6 units.

199. Special Problems. Individual projects or directed reading. Open only to those students who appear competent to carry on individual work. Admission to this course requires the approval of the faculty member under whom the individual work is to be conducted, in addition to the approval of the advisor and the department chair. 1-6 units.

Statistics

Note: Prerequisites must be completed with a grade of ''C-'' or better.

103. Intermediate Statistics. Review of hypothesis testing — one sample. Hypothesis testing — two sample, variance. Regression and correlation. Analysis of variance including two-way. Analysis of categorical data. Non-parametric tests, goodness of fit, and tests for randomness. **Note:** course not applicable for credit to the mathematics major. **Prerequisite:** STAT 1 or 50. 3 units.

115A. Introduction to Probability Theory. Probability axioms, discrete and continuous random variables, functions of random variables, joint densities, expectation, moment generating functions. Chebyshev's inequality, weak law of large numbers, central limit theorem. **Prerequisites:** MATH 31; STAT 1 or 50 recommended. 3 units.

115B. Introduction to Mathematical Statistics. Interval estimation, point estimation, hypothesis testing, the multivariate normal distribution, non-parametric tests. **Prerequisite:** STAT 115A. 3 units.

155. Introduction to Techniques of Operations Research. Formulation and analysis of mathematical models with emphasis on real systems applications. Introduction to Queueing theory and Markov Processes for application. **Prerequisites:** MATH 31; STAT 50, 103, or 115A; MATH 31 may be taken concurrently. Spring only. 3 units.

196. Experimental Offerings in Statistics. When a sufficient number of qualified students applies, one of the staff will conduct a seminar in probability and/or statistics. 1-6 units.

199. Special Problems. Individual projects or directed reading. Open only to students who appear competent to carry on individual work. Admission to this course requires approval of the instructor in addition to the approval of the advisor and the department chair. 1-6 units.

GRADUATE COURSES

Mathematics

Entrance to all graduate courses requires permission of the mathematics graduate advisor.

210A. Algebraic Structures. General algebraic systems and concepts; groups; rings; fields; vector spaces; Galois theory. **Prerequisite:** MATH 110B. Fall only, alternate years. 3 units.

210B. Algebraic Structures. Prerequisite: MATH 210A. Spring only, alternate years. 3 units.

220A. Topology. Point set topology, continuity, compactness, connectedness. **Prerequisite:** MATH 130B. Fall only, alternate years. 3 units.

220B. Topology. Metric spaces, Function spaces, Homotopy theory. **Prerequisites:** MATH 110A, 220A. Spring only, alternate years. 3 units.

230A. Real Analysis. Metric topology; the theory of the derivative; measure theory. **Prerequisite:** MATH 130B. Fall only, alternate years. 3 units.

230B. Real Analysis. The theory of the integral, including Riemann, Riemann Stieltjes, and Lebesque integrals. Prerequisites: MATH 230A. Spring only, alternate years. 3 units.

234A. Complex Analysis. Complex numbers, complex functions, analytic functions, complex integration, harmonic functions. **Prerequisite:** MATH 130B; MATH 105B or 134 is recommended. Fall only, alternate years. 3 units.

234B. Complex Analysis. Sequences, series, infinite products, conformal mapping, Dirichlets problem, analytic continuation, entire functions, Riemann Zeta function, normal families. **Prerequisites:** MATH 234. Spring only, alternate years. 3 units.

241A. Methods of Applied Mathematics I. Topics in applied mathematics selected from: mathematical analysis (asymptotic expansions, perturbation methods, mappings and transforms, solutions of ordinary and partial differential equations). May be repeated for credit provided topic is not repeated. **Prerequisite:** MATH 105A recommended. Fall only, alternate years. 3 units.

241B. Methods of Applied Math II. Calculus of variations, integral equations, functional analysis. May be repeated for credit provided topic in not repeated. Prerequisites: MATH 241A. Spring only, alternate years. 3 units

296. Experimental Offerings in Mathematics. With demand from a sufficient number of qualified students, one of the staff will conduct a seminar on some topics in mathematics. 1-6 units.

299. Special Problems. Any properly qualified student who wishes to pursue a problem may do so if the proposed subject is acceptable to the supervising instructor and to the student's advisor. 1-6 units.

500. Culminating Experience. Directed reading programs for master's candidates preparing for written comprehensive examinations. Open only to students who have been advanced to candidacy and have secured the permission of the graduate coordinator. Graded Credit/No Credit. 1-3 units.

Statistics

215A. Introduction to Mathematical Statistics. Probability measure, conditional probability and independence, random variables, characteristic and moment-generating functions, modes of convergence. **Prerequisites:** STAT 115A, 115B; MATH 134 is recommended. Fall only, alternate years. 3 units.

215B. Introduction to Mathematical Statistics. Point and interval estimation, hypothesis testing, nonparametric statistics, the general linear hypothesis, and multivariate statistics. **Prerequisites:** STAT 215A. Spring only, alternate years. 3 units.

296. Experimental Offerings in Statistics. When a sufficient number of qualified students applies, one of the staff will conduct a seminar on advanced topics in statistics. 1-6 units.

299. Special Problems. Any properly qualified student who wishes to pursue a problem may do so if the proposed subject is acceptable to the department committee, the supervising instructor and the student's advisor. 1-6 units.