NOTE:
This document is specific to the
2002-2004 printed catalog.

mathematics and statistics

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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 Master's Degree graduates now teaching at community colleges throughout the state. Upper division majors may check with the Mathematics Administrative Support Coordinator 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

Wallace Etterbeek, *Chair*

Elaine Alexander, Edward Bradley, Elizabeth Ebrahimzadeh, Roland Esquerra, Robert Etter, Wallace Etterbeek, Scott Farrand, James Gehrmann, Roberta Gehrmann, Charles Hagopian, Howard Hamilton, John Ingram, Robert Jaffa, Elaine Kasimatis, Earl Kymala, Roger Leezer, Marcus Marsh, K. C. Ng, Doraiswamy Ramachandran, Geetha Ramachandran, Thomas Schulte, Gary Shannon, Ed Shea, Donald Taranto, Lisa Taylor, Kecheng Zhou

Sharon Jordan, *Administrative Support Coordinator*
Department Office, Brighton Hall 141, (916) 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

DEGREE REQUIREMENTS • BA

Units required for Major: 47-51
Minimum total units required for the BA: 120
Courses in parentheses are prerequisites.

A. *Lower Division Core Courses (20-21 units)*
(4) MATH 030 Calculus I (MATH 029 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) MATH 031 Calculus II (MATH 030 or appropriate high school AP credit)
(4) MATH 032 Calculus III (MATH 031)
(3) MATH 035 Introduction to Linear Algebra (MATH 030 or appropriate high school AP credit)
(3) MATH 045 Differential Equations for Science and Engineering (MATH 031)
(2-3) Select one of the following:
CSC 010 Introduction to Programming (Passing grade on the ELM)
CSC 015 Programming Concepts and Methodology I (CSC 010 or programming experience)
CSC 022 Visual Programming in BASIC
CSC 025 Introduction to C Programming

B. *Upper Division Core Courses (15 units)*
(3) MATH 108 Introduction to Formal Mathematics (MATH 031, MATH 035)
(3) MATH 110A Modern Algebra (MATH 108)
(3) MATH 110B Modern Algebra (MATH 110A)
(3) MATH 130A Functions of a Real Variable (MATH 032, MATH 045, MATH 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 032)
(6) Select 6 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 031)
(3) STAT 115B Introduction to Mathematical Statistics (STAT 115A)
(6) Select two of the following:
MATH 104 Vector Analysis (MATH 032)
MATH 105A Advanced Mathematics for Science and Engineering I (MATH 032, MATH 045)
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 032)
MATH 150 Introduction to Numerical Analysis (MATH 032 or MATH 045)
MATH 170 Linear Programming (MATH 031; MATH 035 or MATH 100)

STAT 155 Introduction to Techniques of Operations Research (MATH 031; STAT 050, STAT 103, or STAT 115A; MATH 031 may be taken concurrently)

3. Teacher Preparation Program (15 units)
(3) MATH 102 Number Theory (MATH 031)
(3) MATH 121 College Geometry (MATH 031; MATH 032 or MATH 035)
(3) MATH 190 History of Mathematics (MATH 031 and upper division standing in mathematics)
(3) MATH 193 Capstone Course for the Teaching Credential Candidate (Successful completion of at least five of the following: MATH 102, MATH 110A, MATH 110B, MATH 121, MATH 130A, MATH 130B, or MATH 190; MATH 110A or MATH 130A may be taken concurrently)
(3) STAT 001 Introduction to Statistics (MATH 009 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)

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 011A and PHYS 011C 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 Teacher Preparation Program office (Eureka Hall 216, 278-6403).

INTEGRATED MATHEMATICS MAJOR/SINGLE SUBJECT CREDENTIAL PROGRAM

Students in the Integrated Mathematics Major/Single Subject Credential Program (also called the Blended Program in Mathematics) begin their pedagogical studies while they are completing the mathematics courses required for the Bachelor's degree in mathematics. The mathematics requirements include all of the courses required for the subject matter program in mathematics (see above), and Math 198. Students who are interested in being admitted to the Blended Program in Mathematics must plan ahead, and must see their advisor as soon as possible. A sample schedule (starting with the third year) is shown below.

Fall Semester, Year #3

MATH 108	Introduction to Proof
STAT 001	Elementary Statistics
Field Experience (may be within MATH 198 or EDTE 100)	

Spring Semester, Year #3

MATH 110A	Abstract Algebra
MATH 102	Number Theory
MATH 198	Tutoring Seminar
EDBM 105	Multicultural Education

Summer

MATH 190	History of Math

Fall Semester, Year #4

MATH 110B	Abstract Algebra
MATH 121	Euclidean and Non-Euclidean Geometry
MATH 198	Tutoring Seminar
EDTE 106	Educational Psychology

Spring Semester, Year #4

MATH 130A	Real Analysis
MATH 193	Capstone Course
EDTE 384	Reading
EDTE 380	Secondary Teaching - A common field experience for MATH 193, EDTE 384, EDTE 380

Fall Semester, Year #5

MATH 130B	Real Analysis
EDTE 386	Math Methods
Student Teaching	
Seminar	

Spring Semester, Year #5

Student Teaching	
Seminar	

DOUBLE MAJOR • MATHEMATICS AND COMPUTER SCIENCE

Units required for Double Major: 77
Courses in parentheses are prerequisites.

A. *Lower Division Courses (27 units)*

1. Mathematics/Statistics (18 units)

(4)	MATH 030	Calculus I (MATH 029 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)	MATH 031	Calculus II (MATH 030 or appropriate high school based AP credit)
(4)	MATH 032	Calculus III (MATH 031)
(3)	MATH 035	Introduction to Linear Algebra (MATH 030 or appropriate high school based AP credit)
(3)	MATH 045	Differential Equations for Science and Engineering (MATH 031)

2. Computer Science (9 units)

(3)	CSC 015	Programming Concepts and Methodology I. (CSC 010 or programming experience)
(3)	CSC 020	Programming Concepts and Methodology II (CSC 015)
(3)	CSC 035	Assembly Language Programming (CSC 015)

B. *Upper Division Courses (50 units)*

1. Mathematics/Statistics (21 units)

(3)	MATH 108	Introduction to Formal Mathematics (MATH 031, MATH 035)
(3)	MATH 110A	Modern Algebra (MATH 108)
(3)	MATH 130A	Functions of a Real Variable (MATH 032, MATH 045, MATH 108) **OR**
	MATH 134	Functions of a Complex Variable and Applications (MATH 032)
(3)	STAT 115A	Introduction to Probability Theory (MATH 031)
(3)	STAT 115B	Introduction to Mathematical Statistics (STAT 115A)
(6)	Select two of the following:	
	MATH 150	Introduction to Numerical Analysis (MATH 032 or MATH 045)
	MATH 170	Linear Programming (MATH 031; MATH 035 or MATH 100)
	STAT 155	Introduction to Techniques of Operations Research (MATH 031; STAT 050, STAT 103, or STAT 115A; MATH 031 may be taken concurrently)

2. Computer Science (29 units)

(3)	CSC 130	Data Structures and Algorithm Analysis (CSC 020, CSC 028; CSC 028 may be taken concurrently)
(3)	CSC 131	Computer Software for Engineering (CSC 130; may be taken concurrently)
(3)	CSC 134	Database Management and File Organization (CSC 130)
(3)	CSC 136	Programming Languages (CSC 132)
(4)	CSC 137	Computer Organization (CSC 028, CSC 035, CSC 130)
(3)	CSC 139	Operating System Principles (CSC 060, CSC 137 or equivalents)
(3)	CSC 145	Advanced Systems Programming (CSC 035, CSC 060, CSC 130; CSC 060 and CSC 130 may be taken concurrently)
(3)	CSC 148*	Modeling and Experimental Design (MATH 031, STAT 050, and proficiency in at least one programming language)
(2)	CSC 190	Senior Project: Part I (CSC 131, senior standing in CSC, passing score on the WPE) Senior Standing; classification as a Computer Science major (not Pre-Computer Science)
(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 6 upper division units must be taken at CSUS. Specific requirements are:

1. *Option I (20-21 units)*
   - (4) MATH 030   Calculus I (MATH 029 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) MATH 031   Calculus II (MATH 030 or appropriate high school based AP credit)
   - (3-4) Select one of the following:
     - MATH 032   Calculus III (MATH 031)
     - MATH 035   Introduction to Linear Algebra (MATH 030 or appropriate high school based AP credit)
     - STAT 050   Introduction to Probability and Statistics (MATH 026A, MATH 030, or appropriate high school based AP credit)
   - (9) Select 9 units of upper division Mathematics and/or Statistics courses selected with approval of a Mathematics advisor.

2. *Option II (20 units)*
   - (4) MATH 030   Calculus I (MATH 029 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) MATH 031   Calculus II (MATH 030 or appropriate high school based AP credit)
   - (4) MATH 032   Calculus III (MATH 031)
   - (4) MATH 105A   Advanced Mathematics for Science and Engineering I (MATH 032, MATH 045)
   - (4) MATH 105B   Advanced Mathematics for Science and Engineering II (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 6 upper division units is required. At least 6 upper division units must be taken at CSUS. Specific requirements are:

   - (4) MATH 030   Calculus I (MATH 029 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) MATH 031   Calculus II (MATH 030 or appropriate high school based AP credit)
   - (4) MATH 032   Calculus III (MATH 031) **OR**
     - STAT 050   Introduction to Probability and Statistics (MATH 026A, MATH 030, or appropriate high school based AP credit)
   - (3) STAT 115A   Introduction to Probability Theory (MATH 031)
   - (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;
- 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, MATH 110B, MATH 130A, or MATH 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 (CASPER). 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); and
- 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, MATH 220A)	
MATH 234A	Complex Analysis (MATH 130B) **AND**	
MATH 234B	Complex Analysis (MATH 234A)	
MATH 241A	Methods of Applied Mathematics I **AND**	
MATH 241B	Methods of Applied Math II (MATH 241A)	
STAT 215A	Introduction to Mathematical Statistics (STAT 115A, STAT 115B) **AND**	
STAT 215B	Introduction to Mathematical Statistics (STAT 215A)	

- (6) Select one of the following with advisor approval:

MATH 296	Experimental Offerings in Mathematics
MATH 299	Special Problems

  Electives in mathematics and related disciplines

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

B. Culminating Requirement
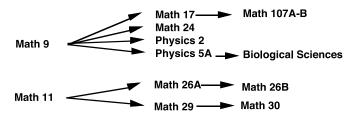 Written Comprehensive Examination

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

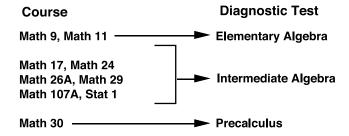Students who have not completed four years of high school mathematics consisting of:

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

Math 9 → Math 17 → Math 107A-B
Math 9 → Math 24
Math 9 → Physics 2
Math 9 → Physics 5A → Biological Sciences

Math 11 → Math 26A → Math 26B
Math 11 → Math 29 → Math 30

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 001, MATH 017, MATH 024, MATH 026A, MATH 026B, MATH 029, MATH 030, MATH 031, MATH 035, STAT 001, and STAT 050.

Students Planning to take any of the following courses: MATH 009, MATH 011, MATH 017, MATH 024, MATH 026A, MATH 029, MATH 030, MATH 107A, or STAT 001 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.

Course	Diagnostic Test
Math 9, Math 11	Elementary Algebra
Math 17, Math 24 Math 26A, Math 29 Math 107A, Stat 1	Intermediate Algebra
Math 30	Precalculus

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 030, Calculus I, must take the pre-calculus diagnostic test prior to the semester of enrollment in MATH 030. Arrangements should be made with the CSUS Testing Center (916) 278-6296.

LOWER DIVISION COURSES

Mathematics

MATH 001. Mathematical Reasoning. Recommended for students whose majors do not include a specific mathematics requirement. 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. Designed to give students an understanding of some of the vocabulary, methods, and reasoning of mathematics with a focus on ideas. **Prerequisite:** MATH 009 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 002)

MATH 009. 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:** Applicable to workload credit for establishing full-time enrollment status, but not applicable to the baccalaureate degree. **Prerequisite:** 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.

MATH 011. College Algebra. Prepares students for MATH 029 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:** Applicable to workload credit for establishing full-time enrollment status, but not applicable to the baccalaureate degree. **Prerequisite:** 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.

MATH 017. An Introduction to Exploration, Conjecture, and Proof in Mathematics. Prepares students for MATH 107A and MATH 107B. Students will explore mathematical patterns and relations, formulate conjectures, and prove their conjectures. Topics from number theory, probability and statistics, and geometry. **Prerequisite:** MATH 009 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.

MATH 024. Modern Business Mathematics. Mathematics for business world, including functions, math of finance, and rates of change. Applications to economics and business will be emphasized throughout the use of case studies. **Prerequisite:** MATH 009 or three years of high school math that includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra Diagnostic Test. 3 units.

MATH 026A. Calculus I for the Social and Life Sciences. Limits, differentiation with applications, integration and applications in the Social Sciences and Life Sciences. **Prerequisite:** MATH 011 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 030).

MATH 026B. Calculus II for the Social and Life Sciences. Continuation of MATH 026A, 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 031 or equivalent. **Prerequisite:** MATH 026A or appropriate high school based AP credit. 3 units. (CAN MATH 032)

MATH 029. Pre-Calculus Mathematics. 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. **Prerequisite:** MATH 011 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 016).

MATH 029A. 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. **Prerequisite:** MATH 011 or three years of high school mathematics that includes two years of algebra and one year of geometry; completion of the Intermediate Algebra Diagnostic Test. **Corequisite:** MATH 029L. 2 units.

MATH 029B. 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 029A. **Corequisite:** MATH 029M. 2 units.

MATH 029L. Lab for Pre-Calculus Math A. A workshop designed to deepen the understanding of pre-calculus developed in MATH 029A. **Note:** May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree. Laboratory: 3 hours. **Corequisite:** MATH 029B. Graded Credit/No Credit. 1 unit.

MATH 029M. Lab for Pre-Calculus Math B. A workshop designed to deepen the understanding of pre-calculus developed in MATH 029B. **Note:** May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree. Laboratory: 3 hours. **Corequisite:** MATH 029B. Graded Credit/No Credit. 1 unit.

MATH 030. Calculus I. Functions and their graphs; limits; the derivative and some of its applications; the integral; the fundamental theorem; some applications of the integral. **Prerequisite:** MATH 029 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 018)

MATH 030L. Laboratory for First Semester Calculus. A workshop designed to deepen the understanding of calculus developed in MATH 030. **Note:** May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree. Laboratory: 3 hours. **Corequisite:** Enrollment in a designated section of MATH 030. Graded Credit/No Credit. 1 unit.

MATH 031. Calculus II. MATH 030 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 030 or appropriate high school based AP credit. 4 units. (CAN MATH 020)

MATH 031L. Laboratory for Second Semester Calculus. A workshop designed to deepen the understanding of calculus developed in MATH 031. **Note:** May be taken for workload credit toward establishing full-time enrollment status, but is not applicable to the baccalaureate degree. Laboratory: 3 hours. **Corequisite:** Enrollment in a designated section of Math 031. Graded Credit/No Credit. 1 unit.

MATH 032. Calculus III. Continuation of Calculus II. Algebra and calculus of vectors; functions of several variables; partial differentiation; multiple integration; vector analysis. **Prerequisite:** MATH 031. 4 units. (CAN MATH 022)

MATH 035. Introduction to Linear Algebra. Careful development of matrices, systems of equations, determinants, vector spaces, linear transformations, orthogonality, real and complex eigenvalues; R3 viewed as a vector space with generalization to Rn. Students will be given periodic writing assignments which encourage them to think through concepts of the course. **Prerequisite:** MATH 030 or appropriate high school based AP credit. 3 units. (CAN MATH 026)

MATH 045. 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 031. 3 units. (CAN MATH 024)

MATH 096. 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.

MATH 099. 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

STAT 001. Introduction to Statistics. Descriptive statistics, basic concepts of probability and sampling with the aim of introducing fundamental notions and techniques of statistical inference. **Prerequisite:** MATH 009 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 002)

STAT 050. 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 026A, MATH 030, or appropriate high school based AP credit. 4 units.

STAT 096. 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

MATH 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 026B or MATH 031. 3 units.

MATH 101. Mathematical Topics for Computer Science. Formal logic including rules of inference and proof by derivation in propositional and predicate logic; logic of inductive and recursive proof and construction of recursive domains; and proofs of correctness procedures and general programming structures. **Prerequisite:** CSC 28, CSC 130. 3 units.

MATH 102. Number Theory. The theory of divisibility; some number theoretical functions; congruencies (linear and quadratic); some Diophantine equations. Simple continued fractions. **Prerequisite:** MATH 031. Spring only. 3 units.

MATH 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 032. Spring only. 3 units.

MATH 105A. Advanced Mathematics for Science and Engineering I. Survey of second order linear differential equations, power series and Fourier series solutions, solution of partial differential equations by separation of variables. **Prerequisite:** MATH 032, MATH 045. 4 units.

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

MATH 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. **Prerequisite:** MATH 017 and passing score on the Intermediate Algebra Diagnostic Test. 3 units.

MATH 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. **Prerequisite:** MATH 107A. 3 units.

MATH 108. Introduction to Formal Mathematics. Logic of mathematical proof, set theory, relations, functions. Examples and applications from set cardinality, algebra, and analysis. **Prerequisite:** MATH 031, MATH 035. 3 units.

MATH 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. **Prerequisite:** MATH 108. 3 units.

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

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

MATH 121. College Geometry. A study of the axioms and theorems of Euclidean geometry. A comparison of several geometry axion systems and their theorems, including those of some non-Euclidean and finite geometries. **Prerequisite:** MATH 031; MATH 032 or MATH 035. Fall only. 3 units.

MATH 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. **Prerequisite:** MATH 032, MATH 045, MATH 108. 3 units.

MATH 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. **Prerequisite:** MATH 130A. 3 units.

MATH 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 032. 3 units.

MATH 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 032 or MATH 045; some computer programming experience is desirable. 3 units.

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

MATH 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.

MATH 170. Linear Programming. Theory of linear programming, duality, simplex method, integer programming, applications. **Prerequisite:** MATH 031; MATH 035 or MATH 100. Fall only. 3 units.

MATH 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. **Prerequisite:** MATH 031 and upper division standing in mathematics. Fall only. 3 units.

MATH 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. **Prerequisite:** Successful completion of at least five of the following: MATH 102, MATH 110A, MATH 110B, MATH 121, MATH 130A, MATH 130B or MATH 190; MATH 110A or MATH 130A may be taken concurrently. Spring only. 3 units.

MATH 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.

MATH 198. Seminar for Mathematics Tutors. Supports CSUS students who are working in tutorial and related roles in mathematics programs on campus. Focus on questioning as a fundamental strategy for teaching mathematics, on classroom observation, and on communication among mathematics instructors in support of effective teaching and learning. **Note:** May be repeated up to two times for credit. **Prerequisite:** Students must be working as tutors in a campus-based program. Graded Credit/No Credit. 2 units.

MATH 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

STAT 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:** Not applicable for credit to the mathematics major. **Prerequisite:** STAT 001 or STAT 050. 3 units.

STAT 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. **Prerequisite:** MATH 031; STAT 001 or STAT 050 recommended. 3 units.

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

STAT 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. **Prerequisite:** MATH 031; STAT 050, STAT 103, or STAT 115A; MATH 031 may be taken concurrently. Spring only. 3 units.

STAT 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.

STAT 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

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

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

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

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

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

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

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

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

MATH 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.

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

MATH 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.

MATH 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.

MATH 500. Culminating Experience. Directed reading programs for master's candidates preparing for written comprehensive examinations. **Note:** 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

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

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

STAT 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.

STAT 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.