

**College of Natural Sciences**

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Thomas J. Carter, Ph.D., *Chair, Department of Computer Science and  
Program Director, Cognitive Studies*

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Shane Phillips, Ph.D., *Chair, Department of Chemistry*

Viji Sundar, Ph.D., *Chair, Department of Mathematics*

Horacio Ferriz, Ph.D., *Program Director, Geology*

Marvin Johnson, Ph.D., *Program Director, Joint Engineering Program*

(vacant), *Program Director, Environmental Sciences*

Pam Roe, Ph.D., *Program Director, Marine Sciences*

In Spring 2006, California State University, Stanislaus created the College of Natural Sciences, composed of the departments of Biological Sciences; Chemistry; Computer Science; Mathematics; and Physics, Physical Sciences, and Geology. The College of Natural Sciences establishes a scientific community dedicated to providing students the intellectual and technological capacity to contribute to and succeed in their academic and scientific pursuits. It seeks to educate students through quality instruction, experiential learning, research and internship opportunities, and strong academic advisement.

Graduates in the academic disciplines within the College of Natural Sciences possess the analytical, problem-solving, and technical skills that are critical to their success in finding, evaluating, and contributing to the body of knowledge in their field, teaching in many arenas and contributing to the well-being of their communities.



**Cognitive Studies Program**

Thomas J. Carter, Ph.D., *Program Director*

**Core Faculty:** Carter (Computer Science), Tuedio (Philosophy),  
Myers, L. (Psychology), Wakefield (Psychology)

**Adjunct Faculty:** Campbell (Accounting), Stanislaw (Psychology),  
Flores (Teacher Education), Taniguchi (History),  
Lindsay (Accounting), Wink (Teacher Education),  
Savini (Art), Strongin (Psychology)

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**Bachelor of Arts in Cognitive Studies**  
**Minor in Cognitive Studies**

The Cognitive Studies degree program offers an integrative approach to the study of human consciousness and cognitive processing. This interdisciplinary and multidisciplinary program draws from fields including Philosophy, Computer Science, Psychology, Neuroscience, Linguistics, Art, Biology, and Physics. Cognitive Studies emphasizes strategies for investigating how real (biological) and artificial (computational) brains individually and cooperatively solve problems, form concepts, process language, interpret visual and other sensory input, and develop understandings of the world. Students in the program will examine traditional approaches to understanding the mind, with a strong emphasis on philosophical, psychological, and physiological approaches.

The degree program includes integrative courses at the introductory and advanced levels that draw from, consolidate, and expand the material students have learned in coursework from the various contributing disciplines. Central themes include the view of consciousness as an information processing system, how consciousness arises from basic physiological processes, the emergence of patterns and adaptive pattern-recognition, and nonlinear dynamical methods for modeling complex systems. Focus is on the use of language, symbols, and images for representing, manipulating, and communicating knowledge. Students are encouraged to examine issues associated with human/machine interfaces, and will explore basic processes of memory and decision, the relation of thought to action, and recent advances in machine intelligence.

Adequate investigations of these phenomena require a synthesis of skills, methods, and knowledge, and depend on considerable facility with information technology tools and systems. Thus, in addition to their broad-based conceptual analysis of intelligent systems, students will be trained in a diversity of scientific methods and techniques, including rigorous quantitative analysis and effective computer simulations. The program will help students develop strong skills in using, understanding, and evaluating information technologies such as Internet resources and database systems. Students will develop strong communication skills, and the ability to present and convey information clearly and effectively orally, in writing, and in Internet-based presentations.

The graduate in Cognitive Studies will be prepared for work in fields requiring strong interdisciplinary problem-solving skills and depending on contemporary information technologies. Students also will be prepared for entry into graduate programs in Cognitive Science or related fields.

**Bachelor of Arts in Cognitive Studies****Requirements**

1. Complete University General Education requirements for the Bachelor of Arts degree (51 units minimum).
2. Complete the following prerequisites to the major (22 units):  
BIOL 1010 Principles of Biology, 3 units  
COGS 2100 Introduction to Cognitive Studies, 3 units  
COGS 2300 Scientific Methods, Models, and Simulations, 3 units  
MATH 1600 Statistics, 4 units **or**  
MATH 1620 Probability and Statistics, 4 units  
PHIL 2100 Logic, 3 units  
PHIL 2230 Modern Philosophy, 3 units  
PSYC 2010 Introduction to Psychology, 3 units
3. Complete the major of 31 units, as approved by the major adviser.

**The Major (31 units)**

1. Required courses (22 units):  
COGS/CS 3150 Nonlinear Systems and Chaos, 3 units  
COGS 4100 Philosophical Aspects of Cognitive Science, 3 units  
COGS 4960 Seminar in Cognitive Studies, 3 units  
ENGL 3750 Introduction to Linguistic Theory, 4 units  
PHIL 3500 Philosophy of Mind (W/P), 3 units  
PSYC 3100 Introduction to Physiological Psychology, 3 units  
PSYC 4400 Cognitive Processes, 3 units
2. Electives (9 units in consultation with adviser/coordinator)  
\*BIOL 3350 Introductory Genetics, 3 units  
\*CDEV 3170 Early Cognitive Development, 3 units  
\*COGS 3100 Communication Networks, 3 units  
COGS/PSYC 4440 Psychology of Workplace Performance, 3 units  
COGS/PSYC 4700 Intelligence, 3 units  
COGS 4960 Seminar in Cognitive Science, 3 units (may be repeated for elective credit)  
\*CS 4410 Automata, Computability, and Formal Languages, 3 units  
\*CS 4450 Coding and Information Theory, 3 units  
\*CS 4480 Artificial Intelligence, 3 units  
PHIL 4150 Cognitive Phenomenology, 3 units  
PHIL 4260 Twentieth Century Philosophy, 3 units  
PHIL 4300 Philosophy of Language, 3 units  
\*PSYC 3400 Introduction to Perception, 3 units

\*Indicates prerequisites beyond those to the major. Other courses may be approved by major adviser.

## Minor in Cognitive Studies

### Requirements (18 units)

1. Required courses (12 units):
    - COGS 2100 Introduction to Cognitive Studies, 3 units
    - COGS 4100 Philosophical Aspects of Cognitive Science, 3 units
    - PSYC 2010 Introduction to Psychology, 3 units, **or**
    - PSYC 2020 Introduction of Psychological Methods, 3 units
    - PSYC 4400 Cognitive Processes, 3 units
  2. Electives (6 units chosen from the following)
    - \*BIOL 3350 Introductory Genetics, 3 units
    - \*CDEV 3170 Early Cognitive Development, 3 units
    - COGS 2300 Scientific Methods, Models, and Simulations, 3 units
    - \*COGS 3100 Communication Networks, 3 units
    - COGS/PSYC 4440 Psychology of Workplace Performance, 3 units
    - COGS/PSYC 4700 Intelligence, 3 units
    - COGS/CS 3150 Nonlinear Systems and Chaos, 3 units
    - COGS 4960 Seminar in Cognitive Science, 3 units  
(may be repeated for elective credit)
    - \*CS 4410 Automata, Computability, and Formal Languages, 3 units
    - \*CS 4450 Coding and Information Theory, 3 units
    - \*CS 4480 Artificial Intelligence, 3 units
    - ENGL 3750 Introduction to Linguistic Theory, 4 units
    - PHIL 3500 Philosophy of Mind (WP), 3 units
    - PHIL 4150 Cognitive Phenomenology, 3 units
    - PHIL 4260 Twentieth Century Philosophy, 3 units
    - PHIL 4300 Philosophy of Language, 3 units
    - PSYC 3100 Introduction to Physiological Psychology, 3 units
    - \*PSYC 3400 Introduction to Perception, 3 units
- \*Additional prerequisites apply. Other courses may be approved by minor adviser.*

## Course Descriptions

### Lower Division

#### **COGS 2100 Introduction to Cognitive Studies (3 units)**

Introduction to issues and methods relevant to the study of natural and artificial cognitive processes. Includes a survey of key developments fueling the Cognitive Revolution along with the major models influencing research on artificial intelligence, nonlinear dynamics (chaos theory), the brain/mind relationship, and their applications to human behavior and information processing. Satisfies G.E. area D2.

#### **COGS 2300 Scientific Methods, Models, and Simulations (3 units)**

(Formerly Cognitive Simulations) Introduction to methods used in scientific research, with emphasis on theories, models, and simulations. Focus on quantitative/mathematical tools and techniques for design and analysis of experiments, with particular attention to interdisciplinary approaches useful in cognitive science. Prerequisite: MATH 0105 or passing score on the ELM test, or equivalent.

### Upper Division

#### **COGS 3100 Communication Networks (3 units)**

The emergence of telecommunications networks is creating new environments for human interactions that are rapidly altering occupational and social dynamics. This course introduces students to the diversity of network technologies and provides them with sufficient hands-on skills to work in this field. Topics include resource sharing, resource access, and communication. Satisfies G.E. area F3. Corequisite: COGS 3102. Prerequisite: Computer background or experience equivalent to CS 1000. (Lecture, 2 hours; laboratory, 2 hours)

#### **COGS 3150 Nonlinear Systems and Chaos (3 units)**

(Same as CS 3150) This course addresses theoretical and quantitative methods useful for work with nonlinear systems from many fields. Together with its laboratory, the course provides experience with phase space maps, Poincare sections, basins of attraction, strange attractors, and fractals and fractal dimensionality. It emphasizes systems best described by discrete math. Examples are drawn from physics, biology, cognitive science, economics, and other areas. Corequisite: COGS 3152. Prerequisite: COGS 2300 or consent of instructor. (Lecture, 2 hours; laboratory, 2 hours)

#### **COGS 3300 Cognition and Verbal Behavior (3 units)**

Cognitive factors affecting the development and complexity of verbal behaviors are examined within the context of brain function and language environments. Prerequisites: COGS 2100 and 2300.

#### **COGS 4100 Philosophical Aspects of Cognitive Science (3 units)**

Intensive examination of the conceptual foundations of Cognitive Science, with an emphasis on the philosophical aspects of current theoretical issues. Analysis will focus on behaviorism and functionalism as models for understanding human cognition. Constructive criticism of the representational model of mind; discussion of the significance of recent developments in neuroscience, and of the connectionist movement in artificial intelligence. Satisfies G.E. area F3. Prerequisite: COGS 2100 or consent of instructor.

#### **COGS 4350 The Information of Meaning (3 units)**

Focuses on the contemporary theory of information and will include applications to biology/genetics, language/ linguistics, cognitive/artificial intelligence, philosophy, and the arts. Satisfies G.E. areas F3 and G. One of two paired courses in the G.E. Summit Program (Humans in the Information Age). Prerequisites: Upper-division standing, completion of lower-division general education, BIOL 4350, and consent of Summit Program Coordinator.

#### **COGS 4440 Psychology of Workplace Performance (3 units)**

(Formerly COGS 3200 Human Factors; same as PSYC 4440) Workplace designs that ignore the psychological abilities of workers reduce productivity, increase turnover, and in extreme cases trigger injuries or fatalities. This course uses real-world examples to demonstrate these problems and how they can be avoided by applying current theories of human performance.

**COGS 4680 Neural Nets and Intelligent Machines (4 units)**

This course, with its associated laboratory, deals with the current designs of cognitive machines that exploit the kind of adaptive parallel processing and self-organizing networks used by brains for learning, memory, visual imaging, and pattern recognition. The laboratory will emphasize the exploration of cognitive models using computer simulation. Corequisite: COGS 4682. Prerequisite: COGS 2300 or consent of instructor. (Lecture, 3 hours; laboratory, 3 hours)

**COGS 4700 Intelligence (3 units)**

(Same as PSYC 4700) The origins and assessment of intelligence and its role in cognitive functions are examined within the psychometric and neuroscientific frameworks.

**COGS 4950 Selected Topics in Cognitive Studies (1-5 units)**

Development of a selected branch of cognitive studies. Topics vary each term, thus different topics may be taken for credit. Prerequisite: Consent of instructor.

**COGS 4960 Seminar in Cognitive Science (3 units)**

Seminar will focus on current developments in the neurosciences and cognitive psychology. Prerequisite: Consent of instructor.

**COGS 4965 Senior Project (1-4 units)**

A senior project developed in an area of Cognitive Studies under the direction of a specific faculty member. Can be taken for a maximum of 6 units total of which 3 units may count toward the major. Prerequisites: Senior standing and consent of instructor.

**COGS 4980 Individual Study (1-4 units)**

For students capable of independent work who need advanced or specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor and coordinator of the Cognitive Studies program.

### Environmental Sciences Concentration

The concentration in Environmental Sciences acquaints students with environmental problems and research in the areas of Biological Sciences, Chemistry, and Physical Sciences. Students will complete courses in each of these areas, participate in interdepartmental seminars, and become involved in the study of an environmentally related problem. Courses are required in each of the departments to help the student better understand the nature and diversity of the environment, as well as the broad scope of research and study necessary to deal effectively with environmental problems.

Each student must satisfy the graduation requirements of the University, including the completion of a major in Biological Sciences, Chemistry, Geology, Physical Sciences, or Physics. In addition, students must complete requirements for the Environmental Sciences concentration as outlined. Students majoring in Physical Sciences may combine the environmental sciences concentration requirements with major requirements to complete the Physical Sciences degree as outlined in the catalog.

**Requirements (55 units minimum)\***

\* *Most of these units will double-count in the major.*

1. Complete the following prerequisites to the Environmental Sciences concentration or their equivalent when available (34-35 units):
  - a. BOTY 1050 Introduction to Botany, 4 units
  - b. ZOOL 1050 Introduction to Zoology, 4 units
  - c. CHEM 1100, 1110 Principles of Chemistry I, II, 10 units
  - d. MATH 1600 Statistics, 4 units, **or**  
MATH 4630 Probability Theory, 3 units
  - e. CS 1000 Introduction to Computers, 3 units
  - f. PHYS 2100, 2110 Basic Physics I, II, 10 units, **or**  
PHYS 2250, 2260 General Physics I, II, 8 units, **and**  
PHYS 2252, 2262 General Physics Lab I, II, 2 units
2. Complete the following coursework for the Environmental Sciences concentration (21-22 units):
  - a. BIOL 4680 Ecology, 4 units
  - b. CHEM 2010 Quantitative Analysis and Basic Instrumental Techniques, 4 units
  - c. MATH 1410 Calculus I, 4 units, **or**  
MATH 1910 Calculus with Applications I, 3 units
  - d. NSCI 4960 Seminar in Environmental Science, 1 unit  
(two semesters required), 2 units
  - e. PHSC 3000 Energy, Ecology, and Environment, 3 units, **or**  
GEOL 3000 Physical and Environmental Geology, 4 units
  - f. BIOL 4980 Individual Study, 4 units, **or**  
CHEM 4980 Individual Study, 4 units, **or**  
GEOL 4980 Individual Study, 4 units, **or**  
PHYS 4980 Individual Study, 4 units

*Note: The individual study must be on an environmentally related problem which has been selected in consultation with the adviser. Each student should include additional environmental courses in consultation with the adviser.*

## Department of Biological Sciences

Mark Grobner, Ph.D., *Chair*

**Professors:** Grillos, Kelly, Kohlhaas, Roe, Watson, Wolf, Janey Youngblom

**Associate Professors:** Bruner, Grobner, Schoenly, James Youngblom

**Assistant Professors:** Gerson, Jones, Stevens, Thao

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**Bachelor of Arts and Bachelor of Science in Biological Sciences  
with concentrations in: Botany, Clinical Laboratory Science,  
Ecology and Field Biology, Entomology, Environmental Sciences,  
Genetics, Marine Biology, Microbiology, and Zoology**

**Minor in Biological Sciences**

**Master of Science in Marine Sciences\***

**Master of Science in Ecology and Sustainability\***

**Master of Science in Genetic Counseling\***

**Liberal Studies degree concentration in Biological Sciences**

\*Please see the Graduate catalog.

## Bachelor of Arts in Biological Sciences

The degree Bachelor of Arts is designed to provide breadth and background in the natural sciences and to allow sufficient flexibility to accommodate the diverse needs of the general student. Persons preparing for careers in such areas as agriculture, industry, and elementary teaching will find this degree adaptable to their career objective.

## Bachelor of Science in Biological Sciences

The degree Bachelor of Science is designed to provide the comprehensive background in the sciences required for students planning to seek a career in secondary teaching or additional training for graduate or professional schools. The degree includes coursework usually required for admission to schools of medicine, dentistry, optometry, pharmacy, veterinary medicine, or laboratory technology, and for admission to graduate work in the biological sciences. Students planning to seek advanced or professional degrees should consult their department adviser early in their undergraduate program to determine what courses are required for graduate and professional programs.

## Requirements for the Bachelor of Arts or the Bachelor of Science

1. Complete University General Education requirements for the bachelor's degree (51 units).
2. Complete the following prerequisites to the major:
  - a. Required courses in the major field (8 units):  
BOTY 1050 Introduction to Botany, 4 units  
ZOOL 1050 Introduction to Zoology, 4 units
  - b. Required courses in supporting fields (14 units for the Bachelor of Arts degree; 25-26 units for the Bachelor of Science degree):
    - i. CHEM 1100, 1110 Principles of Chemistry I, II, 10 units
    - ii. CHEM 3010, 3012 Organic Chemistry I, Lab, 4 units
    - iii. Bachelor of Science Students (11-12 units):
      - Mathematics (statistics or calculus), 3-4 units
      - Physics (one-year sequence), 8 units. (A year sequence comparable to PHYS 2100, 2110, or PHYS 2250, 2252, 2260, 2262.)
3. Complete the major of not less than 25 upper-division units for the Bachelor of Arts or not less than 29 upper-division units for the Bachelor of Science, including course requirements as specified for the majors. No more than 8 units of CR-graded coursework from courses graded exclusively CR/NC may apply toward the major.
4. Completion of a minor or concentration is not required.

## The Major (34-38 units)

1. Animal and Plant Sciences (8 units)

*Note: These must be upper-division, 4- or 5-unit courses with laboratories. With the approval of the major adviser, certain lower-division (4 or 5 units, with lab) bacteriology courses taken at other institutions may be used to satisfy the Botany/Microbiology requirement. Under those circumstances, only 4 units of biology electives may then be at the lower-division level.*

- a. Select one course from Entomology or Zoology.
- b. Select one course from Botany or Microbiology.
- c. One of the above courses must deal with the diversity of organisms. (Acceptable courses are indicated by an asterisk (\*) in the course description section of the catalog.)
2. Complete BIOL 3310 Cellular and Molecular Biology, 3 units
3. Genetics (5-6 units)
  - a. BIOL 3350 Introductory Genetics, 3 units
  - b. Select one course from the following:  
BIOL 4820, 4830, 4840, 4850, 4860, or 4870, 2-3 units
4. Ecology (4 units)  
Select one course from the following:  
BIOL 4630 Marine Ecology, 4 units  
BIOL 4650 Aquatic Biology, 4 units  
BIOL 4680 Ecology, 4 units  
BOTY 4600 Plant Ecology, 4 units
5. Physiology (4 units)  
Select one course from the following:  
BOTY 4200 Plant Physiology, 4 units  
ZOOL 4230 Animal Physiology, 4 units  
ZOOL 4280 Physiology of Human Systems, 4 units

6. Complete 10 units of electives in the Biological Sciences for the Bachelor of Arts degree or 14 units of electives in the Biological Sciences for the Bachelor of Science degree. A maximum of 8 units may be satisfied by courses at the lower-division level with the approval of the major adviser. (BIOL 3000, 3020, 4050, or NSCI 3000 may be used, but no more than 3 units total).
7. Completion of a concentration is optional.

### Elective Concentrations in the Major

#### Requirements (16 units minimum, unless specified otherwise)

Students wishing to have a specific concentration may do so by completing all the requirements for a major in Biological Sciences, to include specific concentration requirements listed below. A minimum of 16 upper-division units must be completed within the area of concentration. Additional units within the concentration will be selected with the assistance of the adviser. Units taken to complete a concentration also count where appropriate, within the major. The following concentrations are offered:

#### 1. Botany

- BOTY 3130 Morphology of Plants, Algae and Fungi, 4 units
- BOTY 3700 Flowering Plants, 4 units
- BOTY 4200 Plant Physiology, 4 units

#### Electives:

An additional 4 units selected with assistance of the adviser.

#### 2. Ecology and Field Biology (17-18 units)

- a. Complete the following required courses:
    - BIOL 4680 Ecology, 4 units
    - BIOL 4830 Evolution and Population Genetics, 2 units
  - b. Complete one of the following courses:
    - BIOL 4000 Biogeography, 3 units
    - BIOL 4300 Conservation Biology, 3 units
    - BIOL 4700 Ecology and Invasive Species, 3 units
  - c. Complete one of the following courses:
    - BIOL 4630 Marine Ecology, 4 units
    - BIOL 4650 Aquatic Biology, 4 units
    - BIOL 4720 Topics in Rocky Intertidal Biology, 4 units
    - BIOL 4740 Deep-Sea Biology, 4 units
    - BOTY 4600 Plant Ecology, 4 units
  - d. Complete one of the following courses:
    - BOTY 3700 Flowering Plants, 4 units
    - ENTO 3000 Principles of Entomology, 4 units
    - ZOOL 3610 General Vertebrate Zoology, 4 units
    - ZOOL 4420 Invertebrate Zoology I, 4 units
    - ZOOL 4430 Invertebrate Zoology II, 4 units
    - ZOOL 4620 Herpetology, 4 units
    - ZOOL 4630 Ornithology, 4 units
    - ZOOL 4640 Mammalogy, 4 units
- Selected MSCI courses with consent of adviser.

#### 3. Entomology

Complete 3 of the following courses:

- ENTO 3000 Principles of Entomology, 4 units
- ENTO 4330 Medical and Veterinary Entomology, 4 units
- ENTO 4800 Agricultural Entomology, 4 units
- ZOOL 4440 General Parasitology, 4 units

#### Electives:

An additional 4 units selected with assistance of the adviser.

#### 4. Environmental Sciences

A biological sciences major may complete additional requirements in the sciences and mathematics to qualify for an Environmental Sciences concentration, in addition to the Bachelor of Arts or Bachelor of Science degree in Biological Sciences. This program requires study in biological sciences, chemistry, computer science, mathematics, and physical sciences, along with an environmental seminar and investigation of an environmentally related problem. Further details are found in the Environmental Sciences Concentration section of this chapter.

#### 5. Genetics

- a. Complete the following required courses:
  - BIOL 3310 Cellular and Molecular Biology, 3 units
  - BIOL 3350 Introductory Genetics, 3 units
- b. Complete one of the following courses:
  - BIOL 4850 DNA Technology in Forensic Science, 2 units, **or**
  - BIOL 4870 Recombinant DNA, 2 units
- c. Complete one of the following courses and corresponding lab:
  - CHEM 4400 and 4402 Biochemistry, 4 units, **or**
  - MBIO 3010 and 3032 Bacteriology, 5 units
- d. Complete two additional advanced genetic courses selected from:
  - BIOL 4820 Medical Genetics, 3 units, **or**
  - BIOL 4830 Evolution and Population Genetics, 2 units, **or**
  - BIOL 4840 Genetic Biotechnology, 3 units, **or**
  - BIOL 4860 Cell Culture and Advanced Biotechnology, 2 units

#### 6. Marine Biology

- ZOOL 4420 Invertebrate Zoology I, 4 units (or MSCI 3240)
  - ZOOL 4430 Invertebrate Zoology II, 4 units (or MSCI 3250)
  - BIOL 4630 Marine Ecology, 4 units (or MSCI 3030)
  - BOTY 3130 Morphology of Plants, Algae, and Fungi, 4 units (or MSCI 3310)
- One term of residence at Moss Landing Marine Laboratories or another marine station.

#### 7. Microbiology

- a. Complete the following required courses (5 units):
  - MBIO 3010 Bacteriology, 3 units
  - MBIO 3032 Bacteriology Laboratory, 2 units
- b. Select elective courses listed below to complete the concentration:
  - BIOL 4100 Immunology, 3 units
  - BIOL 4310 Histological and Cytological Techniques, 4 units
  - MBIO 4300 Medical Microbiology, 4 units
  - MBIO 4600 Food Microbiology, 3 units
  - MBIO 4700 Host-Parasite Interactions, 3 units
  - MBIO 4950 Selected Topics in Microbiology, 1-4 units

BOTY 3500 Introductory Plant Pathology, 4 units  
 ENTO 4330 Medical and Veterinary Entomology, 4 units  
 ZOOL 4440 General Parasitology, 4 units

#### 8. **Zoology**

Select at least one course from each of the following groups:

- a. ZOOL 3610 General Vertebrate Zoology, 4 units  
 ZOOL 4620 Herpetology, 4 units  
 ZOOL 4630 Ornithology, 4 units  
 ZOOL 4640 Mammalogy, 4 units
- b. ZOOL 4420 Invertebrate Zoology I, 4 units  
 ZOOL 4430 Invertebrate Zoology II, 4 units  
 ENTO 3000 Principles of Entomology, 4 units
- c. ZOOL 4230 Animal Physiology, 4 units  
 ZOOL 4280 Physiology of Human Systems, 4 units
- d. An additional 4 units selected with assistance of the adviser.

### **Clinical Laboratory Science Concentration**

The curriculum for the Clinical Laboratory Science concentration includes mandatory classes required for eligibility to take the licensure examination for clinical laboratory scientists offered by the California Department of Health Services. Coursework also prepares students for entry into hospital-based, one-year training programs that are prerequisite to the licensure examination.

1. Complete the following required courses:

BIOL 4100 Immunology, 3 units  
 MBIO 4300 Medical Microbiology, 4 units  
 ZOOL 4440 General Parasitology, 4 units  
 BIO 124 Clinical Hematology, 3 units

*Note: Bio 124 is available on campus via an intercampus distance education offering through concurrent enrollment with CSU Sacramento.*

CHEM 2010 Quantitative Analysis and Basic Instrumental Techniques, 4 units  
 CHEM 4400 Biochemistry I, 3 units

### **Minor in Biological Sciences**

#### **Requirements (20 units)**

1. Complete the following lower-division courses (8 units):  
 BOTY 1050 Introduction to Botany, 4 units  
 ZOOL 1050 Introduction to Zoology, 4 units (equivalent courses may be substituted with approval of minor adviser)
2. Complete a minimum of 12 units of upper-division coursework, as approved by minor adviser.

#### **Liberal Studies Concentration in Biological Sciences**

Please refer to the Liberal Studies section of the catalog.

#### **Preparation for Graduate Work or Professional Degrees**

Biological Sciences majors interested in health careers such as dentistry, medicine, clinical laboratory science, optometry, pharmacy, physical therapy, or veterinary medicine should see the Pre-Health Professions section of this catalog. The University offers the appropriate preprofessional coursework for these areas and the department has fliers which outline the undergraduate courses recommended for each of these career paths.

Consultation with a faculty adviser familiar with preprofessional requirements is strongly recommended at the beginning of the sophomore year.

Students who intend to seek an advanced degree are encouraged to select a minor in the Physical Sciences or Mathematics. A year sequence in college Physics and a year sequence in Organic Chemistry also should be completed. Students interested in an advanced degree in Biochemistry, Ecology, or Molecular Biology should elect a year sequence in Calculus and a course in Statistics.

Students interested in biological laboratory occupations should complete as many courses as possible that focus on laboratory skills and use of equipment, in addition to the traditional Chemistry and Physiology courses completed as part of the Biological Sciences degree.

The following courses also will prepare the student for lab-based graduate or professional degrees:

BIOL 4310 Histological and Cytological Techniques, 4 units  
 BIOL 4850 DNA Technology in Forensic Sciences, 2 units  
 BIOL 4860 Cell Culture and Advanced Biotechnology, 2 units  
 BIOL 4870 Recombinant DNA, 2 units  
 CHEM 2010 Quantitative Analysis and Basic Instrumental Techniques, 4 units  
 CHEM 4400 Biochemistry I, 3 units  
 MBIO 3010 Bacteriology, 3 units  
 MBIO 3032 Bacteriology Laboratory, 2 units

#### **Teaching Credentials**

Majors in Biological Sciences interested in multiple subject or single subject credentials are referred to the Teacher Education section of the Graduate Catalog for a description of teaching credential programs.

### **Master of Science in Marine Sciences Marine Biology Concentration**

The Department of Biological Sciences in conjunction with Moss Landing Marine Laboratories offers a Master of Science in Marine Sciences degree in areas of Marine Sciences. Please see the Graduate catalog or contact the Department of Biological Sciences office for further information.

### Master of Science in Ecology and Sustainability

The Department of Biological Sciences offers a Master of Science in Ecology and Sustainability with concentrations in either Ecological Conservation or Ecological Economics. Please see the Graduate catalog or contact the Department office for further information.

### Master of Science in Genetic Counseling

The Department of Biological Sciences offers a Master of Science in Genetic Counseling with coursework offered at the University of California, San Francisco (UCSF), San Francisco State University, and Oakland Kaiser Permanente Medical Center. Please see the Graduate catalog or contact the Department office for further information.

### Pre-Health Professional Program

Flora Watson (Biological Sciences), Ph.D., *Adviser*

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Students planning to attend medical, dental, pharmacy, veterinary, optometry, chiropractic, physical therapy, physician assistant, clinical laboratory science, or podiatry schools are usually not required to complete a prescribed undergraduate major, although most do. In general, students interested in a health profession major in biological sciences or chemistry. There are courses that are required to be completed before applying to the professional schools.

#### Course Requirements

The minimum requirement for admission to most health professional schools is completion of at least 90 semester units; however, a bachelor's degree is recommended. In addition, requirements for a specific professional school may differ from one school to another. Therefore, it is highly recommended that students, while preparing for admission, examine the requirements of their prospective professional schools and, with the assistance of their major adviser, design a program of study.

#### Experience

It is critical for students to have special health-related experience in addition to their coursework. The experience should have direct patient contact or other interpersonal involvement. The professional schools want to know if the applicants have first-hand knowledge of the realities of a career in a health profession. An undergraduate internship in an appropriate health profession setting is a recommended way to achieve this "real world" experience.

In some situations, experience plays a significant role in the admission selection process. Academic credit may be received for such experiences. Research experience may be useful to some students, but it is not a major requirement for admission to some of the health professions. Consult your major adviser and a member of the Pre-health Professions Committee.

#### Recommended General Education, Core Curriculum, and Elective Courses

##### General Education

Commonly required courses include:

Communication — One semester of Public Speaking (for pharmacy schools)

English – One year of English composition and Literature.

(Note: ESL classes do not fulfill the English requirement.)

Psychology – General Psychology

Social Sciences, Humanities, or Foreign Language

(Minimum of 11 semester units)

##### Core Curriculum

All students who plan to attend a medically related professional school, regardless of major, should take the following core courses:

ZOOL 1050 Introduction to Zoology, with laboratory, 4 units

BOTY 1050 Introduction to Botany, with laboratory, 4 units

CHEM 1100 Principles of Chemistry I, with laboratory, 5 units

CHEM 1110 Principles of Chemistry II, with laboratory, 5 units

CHEM 3010 Organic Chemistry I, 3 units, **and**

CHEM 3012 Organic Chemistry Laboratory, 1 unit

CHEM 3020 Organic Chemistry II, with laboratory, 4 units

CHEM 4400 Biochemistry I, 3 units (highly recommended for dental, medical, and pharmacy schools)

PHYS 2100 Basic Physics I, 5 units, **or**

PHYS 2250 General Physics I, 4 units, **and**

PHYS 2252 General Physics I Laboratory, 1 unit

PHYS 2110 Basic Physics II, 5 units, **or**

PHYS 2260 General Physics II, 4 units, **and**

PHYS 2262 General Physics Laboratory II, 1 unit

MATH 1600 Statistics, 4 units, **and/or**

MATH 1410 Calculus I, 4 units

##### Additional Electives

(to bring the total number of units to at least 90 semester units)

Most professional schools recommend the following courses. Some of these courses may have prerequisites. These courses will also help prepare for professional admissions tests:

BIO 124 Clinical Hematology, 3 units

*Note: BIO 124 is available on campus via a distance education offering with concurrent enrollment from CSU Sacramento.*

BIOL 3350 Introductory Genetics, 3 units

BIOL 4100 Immunology, 3 units

CHEM 3020 Organic Chemistry II, 3 units



CHEM 3022 Organic Chemistry II Laboratory, 1 unit  
 CHEM 4400 Biochemistry I, 3 units  
 MBIO 3010 Bacteriology, 3 units  
 MBIO 3032 Bacteriology Laboratory, 2 units  
 MBIO 4300 Medical Microbiology, 4 units  
 ZOOL 3130 Vertebrate Embryology, 5 units  
 ZOOL 3150 Comparative Anatomy of Vertebrates, 5 units  
 ZOOL 4280 Physiology of Human Systems, with laboratory, 4 units

### Professional Admission Tests

It is to the student's advantage to complete the core curriculum and additional electives before taking the professional admissions test, such as MCAT (Medical College Admission Test), DAT (Dental Admission Test), PCAT (Pharmacy College Admission Test), OAT (Optometry Admission Test), or GRE (Graduate Record Exam for Veterinary School Admission). Application forms, packets, and information are available through the Pre-health Professions Committee. Most professional schools require that all the prerequisite courses be completed by June of the year of intended enrollment.

### Pre-health Professions Committee

A Pre-health Professions Committee provides academic advising and assistance to students who are preparing and applying to health professional schools. Questions regarding pre-health profession preparation and application may be directed to the committee via the Department of Biological Sciences at (209) 667-3476.

### Learning Objectives

Graduates will demonstrate:

- **Biological knowledge:** Knowledge of the basic principles of biology and unifying themes, the processes shared by living things, and an appreciation of the diversity of life that exists on earth.
- **Lab skills:** The ability to use appropriate laboratory/field procedures, methods and instrumentation to conduct biological investigations and safety issues associated with each.
- **Analytical and quantitative skills:** The ability to formulate scientific questions, design experiments to answer these questions, collect, analyze, interpret and report data.
- **Computer literacy:** This is facilitated through laboratory assignments in introductory chemistry, ecology, physiology, and other courses in the core of the degree.
- **Cognitive skills:** The ability to think critically, synthesize as opposed to memorize information presented to them and use this information to solve problems.

Students will demonstrate:

- **Communication skills:** The ability to communicate effectively orally and in writing (scientific writing).
- **Research skills:** The ability to find, evaluate and integrate published information, to use databases and information technology.
- **Stewardship advocacy:** The understanding and appreciation of the relevance of biology to society, the value of knowledge and the lifelong learning, integrity, and the ability to identify and evaluate ethical issues.
- **Teamwork skills:** The ability to work cooperatively and solve problems in a group.

## Course Descriptions

### Biology: Lower Division

#### BIOL 1010 Principles of Biology (3 units)

Introduction to basic biological phenomena common to all living organisms. Cellular and molecular levels of organization, genetics, and the mechanisms of heredity in organic evolution, environmental associations, structure as it relates to function, and reproduction from the molecular to gross structural levels. Satisfies G.E. area B2. (Lecture, 3 hours) (Fall, Winter, Spring)

#### BIOL 1020 World of Biology Laboratory (1 unit)

(Topics to be specified in Class Schedule) Basic laboratory and/or field studies in various biological areas. Satisfies laboratory requirement in natural sciences. Different topics can be taken for credit under this number, but may be taken only once for GE credit. Satisfies G.E. area B2. Prerequisite: BIOL 1010 or concurrent enrollment. (Laboratory, 3 hours) (Fall, Winter, Spring)

#### BIOL 2310 Human Genetics (3 units)

Basic concepts of human genetics will be covered including inheritance patterns of traits, genetic diseases, chromosome aberrations, prenatal diagnosis, the Human Genome Project, and evolutionary genetics. Emphasis will be placed on DNA technology as it relates to current genetic issues. (*Note: This course will not meet the upper-division genetics requirement, nor may it be used as an elective for the genetics concentration.*) Satisfies G.E. area B2. (Lecture, 3 hours) (Fall, Spring)

#### BIOL 2650 Environmental Biology (3 units)

Basic ecological concepts as they apply to present-day resource management and human environmental problems, including wildlife, forest, soil, water, air, and mineral resources. Ecological aspects of air and water pollution, human population growth, pesticide use, and energy consumption. Satisfies G.E. area B2. (Lecture, 3 hours) (Fall, Winter, Spring)

**Biology: Upper Division****BIOL 3000 Frontiers in Biology (3 units)**

Consideration of different topics of biology that are currently in the forefront of research and public awareness. Emphasis is on further development of biological principles learned in lower-division general education courses in natural sciences and in preparing people to deal with questions and decisions relating to biological developments affecting their lives. Topics vary from semester to semester but may include genetic engineering, ecology, cancer research, agricultural developments, disease treatment and control, wildlife and endangered species. May also be used to count towards electives in the major. Satisfies G.E. area FI. Prerequisite: Junior standing and completion of lower-division general education in natural sciences and mathematics. (Lecture, 3 hours) (Fall, Spring)

**BIOL 3020 Introduction to Evolution (3 units)**

An introduction to organic evolution for students unacquainted with the subject. Its implications extend far beyond the confines of biology, ramifying into all phases of human life and activity. May also be used to count towards electives in the major. Satisfies G.E. area FI. Prerequisite: Junior standing and completion of lower-division General Education in natural sciences and mathematics. (Lecture, 3 hours) (Fall, Winter)

**BIOL 3100 Biological Illustration (3 units)**

Techniques of illustrating to include rough drafts and pencil drawings, ink renderings, graphs, maps, lettering, etc., with emphasis placed on biological materials. Corequisite: BIOL 3103. Prerequisite: Consent of instructor. (Lecture, 2 hours; activity, 3 hours) (Spring)

**BIOL 3310 Cellular and Molecular Biology (3 units)**

Basic concepts of cellular phenomena dealt with at the molecular level of organization. Prerequisites: BOTY 1050, ZOOL 1050, CHEM 1100, 1110, or equivalent. (Lecture, 3 hours) (Fall, Spring)

**BIOL 3350 Introductory Genetics (3 units)**

Introduction to classical, molecular, and population genetics. Modern applications including genetic engineering and biotechnology will be discussed. Prerequisites: BOTY 1050, ZOOL 1050, CHEM 1100, 1110, or equivalent. (Lecture, 3 hours) (Fall, Spring)

**BIOL 4000 Biogeography (3 units)**

The relation between geological history, environment, and the distribution and abundance of living organisms. Includes topics on island biogeography, speciation, extinction, and dispersal. Prerequisites: ZOOL 1050 and BOTY 1050 or consent of instructor. (Lecture, 3 hours)

**BIOL 4010 Research and Technical Writing in Biology (WP) (3 units)**

Introduction to bibliographic research, design/interpretation of experiments, statistical testing of results, and preparation of technical reports in biology. Satisfies upper-division writing proficiency requirement. Corequisite: BIOL 4012. Prerequisites: Completion of the Writing Proficiency Screening Test with a passing score, BOTY 1050, ZOOL 1050, junior standing or consent of instructor, and completion of G.E. area A2 requirements (written communication). (Lecture, 2 hours; laboratory, 3 hours) (Fall)

**BIOL 4020 Biology for Decision Making (3 units)**

The study of biological principles of genetic engineering/biotechnology, physiology/medicine, and/or environmental biology to enable students to make informed decisions in their lives. Designed specifically for future teachers. (LIBS Integrative: Scientific/Mathematical Inquiry) Corequisite: BIOL 4022. Prerequisites: General Education areas B and FI. (Lecture 2 hours; laboratory 3 hours; field trips)

**BIOL 4050 Ecosystem Case Studies (3 units)**

Examine how human activities alter the structure and function of ecosystems using local through international examples. Emphasis on the integration of ecosystems components, and roles of science, economic, and social forces in determining policy affecting ecosystems. Satisfies G.E. area FI. Prerequisites: Junior standing and completion of G.E. area B.

**BIOL 4100 Immunology (3 units)**

Introduction to the basic concepts and principles of acquired and innate immunity as they relate to the human body. Prerequisite: BIOL 3310 or BIOL 3350 or MBIO 3010 or CHEM 4400, or consent of instructor.

**BIOL 4110 Concepts in Epidemiology (2 units)**

Interactive introduction to the history and basic fundamentals of epidemiology including general uses, methods, and applications. Corequisite: BIOL 4112. Prerequisite: One of the following: MBIO 3010, BIOL 3310, BIOL 3350, ZOOL 4440, CHEM 4400, or consent of instructor. (Lecture, 1 hour; activity, 2 hours)

**BIOL 4200 Ecological Agriculture (3 units)**

Analysis of ecological patterns and mechanisms of agroecosystems, with emphasis on biodiversity linkages operating between plants, pests, and natural enemies. Topics include environmental and health impacts of genetically engineered plants, pesticide resistance, and critical assessments of integrated pest management, biological control, and sustainability. Case studies from temperate, tropical, and subtropical zones are included to illustrate working examples of ecorational approaches to agriculture. Prerequisite: Course in animal science and plant science or consent of instructor. (Winter)

**BIOL 4300 Conservation Biology (3 units)**

(Formerly BIOL 3300) Current issues in conservation biology, including conservation methods and factors leading to loss of biodiversity. Prerequisites: ZOOL 1050 and BOTY 1050 or consent of instructor. (Lecture, 3 hours)

**BIOL 4310 Histological and Cytological Techniques (4 units)**

Principles and practice of preparing tissues for microscopy study. Corequisite: BIOL 4312. Prerequisite: Two years of college-level biology or equivalent. (Lecture, 2 hours; laboratory, 6 hours) (Fall)

**BIOL 4350 DNA: The Code of Life (3 units)**

A basic introduction to human genetics and explorations into the technological and ethical aspects of current controversial genetics issues. Satisfies G.E. area FI. Prerequisites: Completion of G.E. area B, junior standing.

**BIOL 4610 Elements of Environmental Science (3 units)**

An in-depth exploration of fundamental concepts and processes of science from the perspective of environmental biology. Scientific concepts and processes will be examined through readings, discussions, and activities centered on common phenomena of living systems and prominent local and international environmental issues. Designed specifically for future teachers. (LIBS Integrative: Science/Mathematical Inquiry) Prerequisites: Completion of all math and science requirements in the Liberal Studies major sections A and B and upper-division G.E. area FI with a grade C- or better. (Lecture, 3 hours)

**BIOL 4630 Marine Ecology (4 units)**

(Formerly Marine Biology) Study of marine communities with emphasis on local communities. Ecology and natural history of plants and animals, and their adaptation to marine environments are stressed. Satisfies ecology elective for the major. Corequisite: BIOL 4632. Prerequisites: BOTY 1050, ZOOL 1050 or equivalent, and one semester invertebrate zoology, or BOTY 3100, or consent of instructor. (Lecture, 3 hours; laboratory, 3 hours; field trips) (Spring)

**BIOL 4650 Aquatic Biology (4 units)**

The biota of fresh water with emphasis on the ecology, identification, physiology, and behavior of aquatic organisms. Satisfies the ecology elective for the major. Corequisite: BIOL 4652. Prerequisites: BOTY 1050, ZOOL 1050, and CHEM 1100, 1110, or equivalent. (Lecture, 3 hours; laboratory, 3 hours; field trips) (Spring)

**BIOL 4680 Ecology (4 units)**

Basic interrelationships of plants and animals within their physical environments. Satisfies the ecology elective for the major. Corequisite: BIOL 4682. Prerequisites: BOTY 1050, ZOOL 1050, and statistics or calculus. (Lecture, 3 hours; laboratory, 3 hours; field trips) (Fall)

**BIOL 4700 Ecology and Invasive Species (3 units)**

(formerly Ecology and Exotic Species) Study of ecology of invasive species and their effects on other organisms and ecosystems. Prerequisites: BOTY 1050 and ZOOL 1050 or consent of instructor. (Lecture, 3 hours) (Winter)

**BIOL 4720 Topics in Rocky Intertidal Biology (4 units)**

Field studies of marine rocky intertidal areas of the Central California coastline with in-class data analysis and presentations. Class time variable. Multi-day field trips required. Corequisite: BIOL 4722. Prerequisites: One year of college level Biology courses including BOTY 1050 and ZOOL 1050 or equivalent, and consent of instructor. (Winter)

**BIOL 4740 Deep-Sea Biology (4 units)**

Observations of deep sea animals, data analysis, and student presentations from deep sea studies. Corequisite: BIOL 4742. Prerequisites: One year of college level Biology including ZOOL 1050 and consent of instructor. (Lecture, 3 hours; laboratory, 3 hours) (Winter)

**BIOL 4820 Medical Genetics (3 units)**

(Formerly Cytogenetics) Focuses on clinical aspects of human genetics with an emphasis on symptoms, detection, and treatment of various human disorders that have chromosomal, single gene, or multifactorial origin. Genetic counseling and medical ethics are discussed. Prerequisite: BIOL 3350. (Lecture, 3 hours)

**BIOL 4830 Evolution and Population Genetics (2 units)**

Basic concepts of evolutionary theory and population genetics. Emphasis upon the processes and mechanisms of evolution through genetic changes in populations. Prerequisite: BIOL 3350. (Lecture, 2 hours) (Fall)

**BIOL 4840 Genetic Biotechnology (3 units)**

(formerly Molecular Genetics) Principles and applications of recombinant DNA technology. Emphasis on the tools of gene manipulation, genomic scale analysis, and bioinformatics. Weekly activity involving DNA analysis software. Corequisite: BIOL 4843. Prerequisite: BIOL 3350. (Lecture, 2 hours; activity, 2 hours)

**BIOL 4850 DNA Technology in Forensic Science (2 units)**

Applications of DNA technology in forensic investigation will be explored. The laboratory segment will expose students to a variety of molecular biology techniques used in forensic laboratories. The lecture component will introduce fundamental concepts in molecular biology and expound on the analysis and interpretation of results obtained in the lab. Corequisite: BIOL 4852. Prerequisites: BIOL 2310 or 3350; and CHEM 1100, 1102, and 1104, or consent of instructor. (Lecture, 1 hour; laboratory, 3 hours)

**BIOL 4860 Cell Culture and Advanced Biotechnology (2 units)**

Introduction to tissue culture techniques for analysis of cells under normal and experimental conditions. Emphasis will be placed on application of these techniques for elucidating basic biological functions and their utilization in biotechnology research. Primary focus will be on animal cells, but plant cells also will be examined. Corequisite: BIOL 4862. Prerequisites: BIOL 3350 or BIOL 3310; CHEM 1100, 1110, or equivalent; and consent of instructor. (Lecture, 1 hour; laboratory, 3 hours) (Winter)

**BIOL 4870 Recombinant DNA (2 units)**

(Replaces BIOL 4842) Introduction to the fundamentals of genetic engineering, including the theory and practice of basic recombinant DNA techniques. Corequisite: BIOL 4872. Prerequisite: BIOL 3350. (Lecture, 1 hour; laboratory, 3 hours) (Winter)

**BIOL 4940 Internship in Biology (2-4 units)**

Supervised work in an agency or business related to the biological sciences. Six to twelve hours per week. A weekly one-hour seminar will be held to discuss career-related topics and the work experience aspect of the course. Prerequisites: Junior- or senior-level biology major; consent of instructor. (Fall, Spring)

**BIOL 4950 Selected Topics in Biological Sciences (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of biological sciences. Topics vary each term, thus different topics may be taken for credit. Corequisite: BIOL 4952.

**BIOL 4951 Selected Topics in Biology (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of biological sciences. Topics vary each term, thus different topics may be taken for credit. Corequisite: BIOL 4953.

**BIOL 4960 Biology Colloquium (1 unit)**

Presentation and discussion of selected biological phenomena through the study of biological literature and research. Topics will include both basic and applied research. May be repeated for a total of 6 units, 2 of which can be applied to the major. (Spring)

**BIOL 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor. (Fall, Spring)

**Botany: Lower Division****BOTY 1050 Introduction to Botany (4 units)**

Introduction to the fundamental aspects of plant biology; taxonomy, anatomy, morphology, physiology, and ecology. Satisfies G.E. area B2. Corequisite: BOTY 1052. Prerequisites: Grade of A or B in high school biology, satisfactory score on biology qualifying examination, or BIOL 1010. (Lecture, 3 hours; laboratory, 3 hours) (CAN BIOL 6) (Fall, Spring)

**Botany: Upper Division****BOTY 3000 Principles of Plant Propagation (3 units)**

Techniques, facilities, and materials used in the propagation and maintenance of horticulturally important plants. The water, temperature, and light requirements of domesticated plants also are considered, as well as methods of pest/disease control. Corequisite: BOTY 3002. Prerequisite: BOTY 1050 or equivalent. (Lecture, 2 hours; laboratory, 3 hours; field trips) (Winter)

**BOTY 3050 Plants, Agriculture, and Humans (4 units)**

Introduction to the uses, propagation, and domestication of plants by humans. Corequisite: BOTY 3052. Prerequisite: BOTY 1050 or equivalent. (Lecture, 3 hours; laboratory, 3 hours; field trips) (Fall odd-numbered years)

**\*BOTY 3130 Morphology of Plants, Algae, and Fungi (4 units)**

(Formerly BOTY 3100 and 3120) A comparative study of the structure, development, ecology, evolutionary relationships and economic importance of plants, algae, and fungi. Satisfies the departmental diversity requirement. Corequisite: BOTY 3132. Prerequisite: BOTY 1050 or equivalent. (Lecture, 3 hours; laboratory, 3 hours; field trips). (Fall even-numbered years)

**BOTY 3500 Introductory Plant Pathology (4 units)**

Nature, cause, and control of plant diseases with emphasis on economic agriculture crops. Corequisite: BOTY 3502. Prerequisite: BOTY 1050 or equivalent. (Lecture, 3 hours; laboratory, 3 hours) (\*\*)

**\*BOTY 3700 Flowering Plants (4 units)**

Structure, kinds, taxonomic relationships, and classification of local flowering plants with practice in their collection and identification. Satisfies the departmental diversity requirement. Corequisite: BOTY 3702. Prerequisite: BOTY 1050 or equivalent. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Spring)

**BOTY 4200 Plant Physiology (4 units)**

Selected topics pertaining to metabolism, nutrition, and growth of plants. Satisfies the physiology elective for the major. Corequisite: BOTY 4202. Prerequisites: BOTY 1050 or equivalent, BIOL 3310, and CHEM 3010, 3012, or equivalent. (Lecture, 2 hours; laboratory, 6 hours) (Spring)

**BOTY 4600 Plant Ecology (4 units)**

Study of the interrelationships between plants and their environment, with special emphasis on the structure, development, and causes of distribution of plant communities. Satisfies the ecology elective for the major. Corequisite: BOTY 4602. Prerequisites: One year of college-level biology, including BOTY 1050, CHEM 1100, 1110, or equivalent. (Lecture, 3 hours; laboratory, 3 hours; field trips) (Spring)

**BOTY 4950 Selected Topics in Botany (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of botany. Topics vary each term, thus different topics may be taken for credit. Corequisite: BOTY 4952. Prerequisite: Consent of instructor.

**BOTY 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor.

**Entomology: Upper Division****\*ENTO 3000 Principles of Entomology (4 units)**

Classification, control, life history, structure, ecology, and basic physiology of insects. Satisfies the departmental diversity requirement. Corequisite: ENTO 3002. Prerequisite: ZOOL 1050 or equivalent. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Fall)

**\*ENTO 4330 Medical and Veterinary Entomology (4 units)**

(Formerly ENTO 3330) Natural history and taxonomy of arthropods of medical (including forensic) and veterinary importance in temperate, tropical, and subtropical regions of the world with emphasis on the role arthropods play as vectors and transmitters of disease. The laboratory involves techniques of collection and taxonomic identification, dissections, and field experiments on carrion-arthropod succession to demonstrate the utility of arthropods in medicolegal investigations. Satisfies the departmental diversity requirement. Corequisite: ENTO 4332. Prerequisite: One year of college-level Biology including ZOOL 1050 or equivalent. (Lecture, 3 hours; laboratory, 3 hours; field trips and experiments) (Fall)

**\*ENTO 4800 Agricultural Entomology (4 units)**

An ecologically based holistic survey of pest-natural enemy interactions of selected Central Valley crops emphasizing the origin, identification, biology, damage symptoms, and biological control of insect pests. Related topics will include population and community sampling methods, pest management decision-making and forecasting, host-plant resistance, insect outbreaks, trophic cascades, and food web dynamics. The laboratory component will survey local pest and natural enemy complexes of important row, fiber, and orchard crops. Satisfies the departmental diversity requirement. Corequisite: ENTO 4802. Prerequisites: One year of college-level Biology including ZOOL 1050 or equivalent. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Spring)

**ENTO 4950 Selected Topics in Entomology (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of Entomology. Topics vary each term, thus different topics may be taken for credit. Prerequisite: Consent of instructor.

**ENTO 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor.

**Microbiology: Lower Division****MBIO 2010 Microbiology for Nursing (4 units)**

Introduction to the basic concepts and principles of microbiology as it affects human health. An overview of disease transmission, immunology, physical and chemical methods of disease prevention and control, as well as major infectious diseases of the body systems. Basic laboratory techniques will also be presented. (*Note: This course may not be used as a Biology elective.*) Corequisite: MBIO 2012. Prerequisites: registration in the Nursing program and courses in Biochemistry and Physiology. (Lecture, 3 hours; laboratory, 3 hours)

**Microbiology: Upper Division****\*MBIO 3010 Bacteriology (3 units)**

Morphology, physiology, cultivation, and control of bacteria and other selected microorganisms; their role as agents of change in the natural process important to industry, agriculture, and health. Prerequisites: One year of college-level Biology or equivalent, and CHEM 1110 or equivalent. MBIO 3010 and 3032 together will satisfy the departmental diversity requirement. (Lecture, 3 hours) (Fall, Spring) (\*\*)

**\*MBIO 3032 Bacteriology Laboratory (2 units)**

Laboratory experiments and demonstrations to illustrate principles and techniques of bacteriology. Prerequisite: MBIO 3010 or concurrent enrollment. MBIO 3010 and 3032 together will satisfy the departmental diversity requirement. (Laboratory, 6 hours) (Fall, Spring)

**MBIO 4300 Medical Microbiology (4 units)**

Principles of medical microbiology, including pathogenic microbes, epidemiology, infection, disease, and treatment. Corequisite: MBIO 4302. Prerequisites: MBIO 3010 and 3032. (Lecture, 3 hours; laboratory, 3 hours)

**MBIO 4600 Food Microbiology (3 units)**

Basic concepts related to some biochemical changes by microorganisms in food, including milk and milk products, particularly food spoilage, food poisoning, food preservation, and measures to prevent food spoilage and poisoning. Prerequisite: MBIO 3010 or equivalent. (Lecture, 3 hours) (Spring)

**MBIO 4700 Host-Parasite Interactions (3 units)**

Concept of host-parasite interactions with emphasis on those microorganisms associated with human health and welfare. Prerequisite: MBIO 3010 or equivalent.

**MBIO 4950 Selected Topics in Microbiology (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of microbiology (bacteriology). Topics vary each term, thus different topics may be taken for credit. Prerequisite: Consent of instructor.

**MBIO 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor.

**Natural Science: Upper Division****NSCI 3000 Science for Self-Sufficiency (3 units)**

Theoretical and practical aspects of science related to a self-sufficient life style, including organic agriculture and pest control; plant propagation; food preservation; production of beer, wine, cheese, and other foods; human nutrition; transmission and control of infectious diseases; water treatment and waste disposal; environmental physiology; and production of energy. Satisfies G.E. area F1. Prerequisite: Junior standing. (\*\*)

**NSCI 4960 Seminar in Environmental Science (1 unit)**

Environmental topics will be presented and discussed by faculty, students, and visiting scientists. May be repeated for a maximum of 4 units. Prerequisite: Upper-division standing or consent of instructor.

**NSCI 4961 Teaching Secondary Science (3 units)**

An introduction to teaching methodology, philosophy, resources, and strategies for prospective secondary science teachers for grades 7-12. The course is required for the subject matter preparation program for students who intend to earn the Single Subject Credential in Science and is appropriate for those wanting specialized preparation in Biological Science, Chemistry, Geoscience, or Physics. May be used as an elective in the major.

**Zoology: Lower Division****ZOOL 1050 Introduction to Zoology (4 units)**

Introduction to basic principles common to the animal kingdom. Covers animal diversity; morphology and physiology of animal cells, tissues, and organ systems; animal reproduction and development; and principles of evolution and specialization. Satisfies G.E. area B2. Corequisite: ZOOL 1052. Prerequisites: Grade of A or B in high school biology; satisfactory score on biology qualifying examination, or BIOL 1010. (Lecture, 3 hours; laboratory, 3 hours; field trips) (CAN BIOL 4) (Fall, Spring)

**ZOOL 2230 Physiology (3 units)**

Principles of functional anatomy and physiology of organ systems with special reference to human physiology. Does not satisfy the Physiology elective for the major. Prerequisite: BIOL 1010, or ZOOL 1050, or ZOOL 2250. (Lecture, 3 hours) (CAN BIOL 12) (Fall, Spring)

**ZOOL 2232 Physiology Laboratory (1 unit)**

(Formerly ZOOL 2242) Laboratory experiments, exercises, and demonstrations illustrating the principles of physiology with special reference to human physiology. Prerequisite: ZOOL 2230 or concurrent enrollment. (Laboratory, 3 hours) (Fall, Spring)

**ZOOL 2235 Human Physiology (4 units)**

Principles of functional anatomy and physiology of organ systems with special reference to human physiology. Laboratory exercises and experiments illustrating the principles presented in lecture. Corequisite: ZOOL 2245. (Lecture, 3 hours; laboratory, 3 hours)

**ZOOL 2250 Human Anatomy (4 units)**

Gross morphology and anatomy of the organ systems of the human body with emphasis on functional anatomy. Corequisite: ZOOL 2252. Prerequisites: BIOL 1010 and 1020, or ZOOL 1050. (Lecture, 2 hours; laboratory, 6 hours) (CAN BIOL 10) (Fall, Spring)

**ZOOL 2660 Birdwatching in Central California (3 units)**

Field experience in becoming familiar with the identification, habitats, and habits of birds of Central California. Emphasis on identifying species in the field. Corequisite: ZOOL 2663. Prerequisite: Consent of instructor. (Lecture, 1 hour; activity, 4 hours; field trips) (Winter)

**Zoology: Upper Division****ZOOL 3130 Vertebrate Embryology (5 units)**

Comparative study of embryological stages of various selected vertebrate forms and developmental microanatomy of their organ systems. Corequisite: ZOOL 3132. Prerequisite: ZOOL 1050 or equivalent. (Lecture, 3 hours; laboratory, 6 hours) (\*\*)

**ZOOL 3150 Comparative Anatomy of Vertebrates (5 units)**

Comparative study of microanatomy and gross morphology of organ systems in representative vertebrates. Corequisite: ZOOL 3152. Prerequisite: ZOOL 1050 or equivalent. (Lecture, 3 hours; laboratory, 6 hours) (\*\*)

**ZOOL 3600 Introduction to Ethology (3 units)**

A general survey of forms of animal behavior and methods of study. Prerequisite: BOTY 1050, ZOOL 1050, or consent of instructor. (Lecture, 3 hours) (\*\*)

**\*ZOOL 3610 General Vertebrate Zoology (4 units)**

Natural history, behavior, ecology, environmental physiology, and zoogeography of the vertebrates with emphasis on the ecological roles of vertebrates in their natural communities. Laboratory and field studies of local forms. Satisfies the departmental diversity requirement. Corequisite: ZOOL 3612. Prerequisite: One year college-level Biology. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Fall)

**ZOOL 3660 Birdwatching in Central California (3 units)**

Field experience in becoming familiar with the identification, habits, and habitats of birds of Central California. Emphasis on identifying species in the field. Corequisite: ZOOL 3663. Prerequisites: ZOOL 1050 and consent of instructor. (Lecture, 1 hour; activity, 4 hours; field trips) (Winter)

**ZOOL 4151 Animal Cells and Tissues (4 units)**

Study of various animal cell types and tissues with emphasis on their microstructure and functional relationships. Photomicrography and microphotography will be part of the laboratory experience. Corequisite: ZOOL 4152. Prerequisites: One year of college-level biology, including ZOOL 1050, plus CHEM 1110. (Lecture, 3 hours; laboratory, 3 hours) (\*\*)

**ZOOL 4230 Animal Physiology (4 units)**

A physiological approach to the evolution of vertebrate organ systems. Satisfies the Physiology elective for the major. Corequisite: ZOOL 4232. Prerequisites: BIOL 3310 and CHEM 3010, 3012, or equivalent. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Spring)

**ZOOL 4250 Vertebrate Endocrinology (3 units)**

(Formerly Endocrinology) Study of the role of chemical messengers, or hormones, whether they are of endocrine or neural origin, in the control of physiological processes in vertebrates. Hormone source, synthesis, secretion, physiological roles, and pathophysiology will be stressed. Prerequisites: ZOOL 1050 and CHEM 3010, 3012, or equivalent. (Lecture, 3 hours) (Fall)

**ZOOL 4280 Physiology of Human Systems (4 units)**

Human physiology presented at cellular and organ system levels: membrane transport, nerve excitation, muscle contraction, cardiovascular physiology, kidney function, hormone function, reproduction, and digestion. Satisfies the Physiology elective for the major. Corequisite: ZOOL 4282. Prerequisites: BIOL 3310 and one term of Organic Chemistry. (Lecture, 3 hours; laboratory, 3 hours) (Fall, Spring)

**\*ZOOL 4420 Invertebrate Zoology I (4 units)**

Structure, classification, distribution, and life histories of invertebrate groups including Protozoa, Porifera, Cnidaria, Acoelomates, Pseudocoelomates, and related phyla. Satisfies the department diversity requirement. Corequisite: ZOOL 4422. Prerequisites: Three college-level Biology courses, including ZOOL 1050, or consent of instructor. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Fall)

**\*ZOOL 4430 Invertebrate Zoology II (4 units)**

Structure and classification, distribution, and life histories of invertebrate phyla, including Annelida, Arthropoda, Mollusca, and related groups. Satisfies the departmental diversity requirement. Corequisite: ZOOL 4432. Prerequisites: Three college-level Biology courses, including ZOOL 1050, or consent of instructor. ZOOL 4420 recommended. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Spring)

**\*ZOOL 4440 General Parasitology (4 units)**

Parasitism with emphasis on parasites of man. Satisfies the departmental diversity requirement. Corequisite: ZOOL 4442. Prerequisite: Two years of college-level Biology or equivalent. (Lecture, 3 hours; laboratory, 3 hours) (Fall)

**\*ZOOL 4620 Herpetology (4 units)**

Anatomy, behavior, classification, distribution, ecology, evolution, and life histories of amphibians and reptiles. Satisfies the departmental diversity requirement. Corequisite: ZOOL 4622. Prerequisite: ZOOL 1050 or equivalent, or consent of instructor. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Spring of alternate years)

**\*ZOOL 4630 Ornithology (4 units)**

Behavior, classification, economic importance, evolution, life histories, migration, and special modifications of birds. Identification in field and laboratory. Satisfies the departmental diversity requirement. Corequisite: ZOOL 4632. Prerequisite: ZOOL 1050 or consent of instructor. (Lecture, 2 hours; laboratory, 6 hours; field trips) (Spring of alternate years)

**\*ZOOL 4640 Mammalogy (4 units)**

Classification, distribution, ecology, behavior, and form and function as they relate to life histories of mammals; identification in the field and laboratory. Satisfies the departmental diversity requirement. Corequisite: ZOOL 4642. Prerequisite: ZOOL 1050 or consent of instructor. (Lecture, 2 hours; laboratory, 6 hours; weekend field trips). (Spring of alternate years)

**ZOOL 4650 Field Study: Wood Duck (1 unit)**

Students will become acquainted with the nesting biology of wood ducks during an introductory meeting and weekly field observations. Students will monitor several nest boxes placed near various waterways in Stanislaus County. Copies of field observations will be turned in weekly and at the end of the semester, along with final interpretation of data. May be repeated for up to 2 units. Prerequisite: ZOOL 1050 or consent of instructor. (Spring)

**ZOOL 4950 Selected Topics in Zoology (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of Zoology. Topics vary each term, thus different topics may be taken for credit. Prerequisite: Consent of instructor.

**ZOOL 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor.

(\* ) These courses are acceptable for section 1.c requirement for the major.

(\*\* ) These courses are not offered on a yearly basis.

**Department of Chemistry**

Shane L. Phillips, Ph.D., *Chair*

**Professors:** Byrd, Perona, Stone

**Associate Professor:** Phillips

**Assistant Professors:** Russell, C. Stessman, N. Stessman

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**Bachelor of Arts and Bachelor of Science in Chemistry  
with a concentration in Environmental Sciences  
Minor in Chemistry  
Liberal Studies degree concentration in Chemistry**

**Bachelor of Arts in Chemistry**

The Bachelor of Arts degree program is designed for students seeking to enter professions requiring moderate training in chemistry combined with training in other areas. Examples are technical sales writing, chemical patent law, library work, and high school teaching, as well as health professions such as medicine, optometry, dentistry, medical technology, pharmacy, physical therapy, and veterinary medicine. Students are advised to take specific courses depending on their field of interest; for example, ZOOL 1050, CHEM 4020, 4400, and ZOOL 3130 or ZOOL 3150, or both, in preparation for dental, medical, or veterinary medical schools.

Further information on the health professions area can be obtained from the Pre-Health Professional Program. (See the Biological Sciences section.)

**Bachelor of Science in Chemistry**

The Bachelor of Science degree program is accredited by the American Chemical Society (ACS) and provides comprehensive training in chemistry for students wishing to become professional chemists in industry or government, or who plan to attend graduate school. Students wishing to receive a degree accredited by the ACS must complete CHEM 4400, CHEM 4610, and either MATH 2530 or MATH 2460, in addition to the Bachelor of Science degree requirements listed. Students obtaining an accredited degree are eligible to join the ACS immediately upon graduation.

**Bachelor of Arts or Bachelor of Science in Chemistry****Requirements**

- Complete University General Education requirements for the bachelor's degree (51 units minimum).
- Complete the following prerequisites to the major; CR grades will not be accepted for chemistry course prerequisites.
  - Complete the following required courses in the major field (14 units):  
CHEM 1100, 1110 Principles of Chemistry I, II, 10 units  
CHEM 2010 Quantitative Analysis and Basic Instrumental Techniques, 4 units
  - Bachelor of Arts students complete the following required courses in supporting fields (21 units):
    - CS 1500 Computer Programming I, 3 units, or equivalent by advisement
    - MATH 1410, 1420 Calculus I, II, 8 units
    - PHYS 2100, 2110 Basic Physics I, II, 10 units, **or**  
PHYS 2250, 2260 General Physics I, II, 8 units, **and**  
PHYS 2252, 2262 General Physics Laboratory I, II, 2 units
  - Bachelor of Science students complete the following required courses in supporting fields (25 units):  
CS 1500 Computer Programming I, 3 units, or equivalent by advisement  
MATH 1410, 1420 Calculus I, II, 8 units  
MATH 2410 Multivariate Calculus, 4 units  
PHYS 2250, 2260 General Physics I, II, 8 units  
PHYS 2252, 2262 General Physics Laboratory I, II, 2 units
- Complete a major of not less than 24 upper-division units as specified for the Bachelor of Arts degree, or 31 upper-division units as specified for the Bachelor of Science degree; of these, no more than eight units of CR-graded coursework in courses graded exclusively CR/NC may apply toward the major. Transferred lower division courses (such as community college courses) may be used to fulfill subject requirements, but these will not count towards the minimum number of upper-division units in the major.
- Completion of a minor is not required.

**The Bachelor of Arts Major (24 units)**

- Complete the following courses (17 units):  
CHEM 3010, 3020 Organic Chemistry I, II, 6 units  
CHEM 3012, 3022 Organic Chemistry Lab I, II, 2 units  
CHEM 4010 Physical Chemistry I, 3 units  
CHEM 4012 Physical Chemistry Lab I, 1 unit  
CHEM 4021 Additional Topics in Physical Chemistry, 1 unit  
CHEM 4100 Instrumental Analysis, 4 units
- Select a minimum of seven credit hours from the following courses:  
CHEM 4020 Physical Chemistry II, 3 units  
CHEM 4022 Physical Chemistry Lab II, 1 unit  
CHEM 4200 Advanced Inorganic Chemistry, 3 units  
CHEM 4212 Advanced Chemistry Laboratory, 2 units  
CHEM 4300 Advanced Organic Chemistry, 3 units  
CHEM 4400 Biochemistry I, 3 units  
CHEM 4402 Biochemistry Laboratory I, 1 unit  
CHEM 4420 Biochemistry II (VWP), 3 units  
CHEM 4940 Chemistry Internship, 2-4 units

- CHEM 4950 Selected Topics in Chemistry, 1-5 units  
CHEM 4960 Research Seminar, 1 unit  
CHEM 4961 Seminar on Directed Readings, 1 unit  
CHEM 4980 Individual Study, 1-4 units

**The Bachelor of Science Major (31 units)**

- Complete the following courses (25 units):  
CHEM 3010, 3020 Organic Chemistry I, II, 6 units  
CHEM 3012, 3022 Organic Chemistry Laboratory I, II, 2 units  
CHEM 4010, 4020 Physical Chemistry I, II, 6 units  
CHEM 4012, 4022 Physical Chemistry Laboratory I, II, 2 units  
CHEM 4100 Instrumental Analysis, 4 units  
CHEM 4200 Advanced Inorganic Chemistry, 3 units  
CHEM 4212 Advanced Chemistry Laboratory, 2 units
- Select a minimum of six credit hours from the following courses:  
CHEM 4300 Advanced Organic Chemistry, 3 units  
CHEM 4400 Biochemistry I, 3 units  
CHEM 4402 Biochemistry Laboratory I, 1 unit  
CHEM 4420 Biochemistry II (VWP), 3 units  
CHEM 4610 Computer Methods in Chemistry, 2 units  
CHEM 4940 Chemistry Internship, 2-4 units  
CHEM 4950 Selected Topics in Chemistry, 1-5 units  
CHEM 4960 Research Seminar, 1 unit  
CHEM 4961 Seminar on Directed Readings, 1 unit  
CHEM 4980 Individual Study, 1-4 units  
PHYS 3520 Modern Physics and Quantum Mechanics, 3 units  
PHYS 4450 Nuclear and Particle Physics, 3 units  
PHYS 4530 Thermal and Statistical Physics, 4 units

*Note: The following are required for an ACS-accredited degree (7-8 units).*

- CHEM 4400 Biochemistry I, 3 units
- CHEM 4610 Computer Methods in Chemistry, 2 units
- MATH 2460 Introduction to Differential Equations, 2 units **or**  
MATH 2530 Linear Algebra, 3 units

**Minor in Chemistry**

The minor in Chemistry requires successful completion of 18 units in Chemistry as approved by the department, including a minimum of 8 upper-division units, with a grade point average of 2.0 or higher.

**Environmental Sciences Concentration**

A Chemistry major may complete additional requirements in the sciences and mathematics to qualify for a concentration in Environmental Sciences. This program requires study in biological sciences, chemistry, computer science, mathematics, and physical sciences, along with an environmental seminar and investigation of an environmentally related problem. Further details are found in the Environmental Sciences section of this catalog.



**Liberal Studies Concentration in Chemistry**

Please refer to the Liberal Studies section of the catalog.

**Teaching Credentials**

Majors in chemistry interested in multiple subject or single subject credentials are referred to the Teacher Education section of the Graduate Catalog for a description of teaching credential programs.

**Learning Objectives**

Students will demonstrate:

- An understanding of atoms, ions, and molecules and their relationship to chemical and physical properties of matter.
- A working knowledge of fundamental chemical principles and how they apply to the real world.
- A firm knowledge of major classes of chemicals, their reactivity, and their physical properties.
- The ability to evaluate the quality and usefulness of their data in reaching a conclusion.
- The ability to effectively communicate scientific information orally and in writing.
- The ability to search and find information in the chemical literature.
- The ability to critically evaluate scientific communications (written and oral).
- Independent work and teamwork in the laboratory.
- Competency multi-tasking in the laboratory.

Students will utilize:

- The scientific method to question, to design and perform experiments, and to devise and evolve theories on chemical phenomena.
- Modern methods of chemical synthesis, characterization, and analysis.
- Modern laboratory instrumentation in their experimental work.

Students will apply:

- Mathematical skills and reasoning to derive quantitative results on which their conclusions are based.
- Fundamental chemical principles to design experiments, collect data, and assess the results.

Students will communicate scientific information in writing.

Students will document experimental work in a scientific format.

Graduates will think critically in analysis of chemical properties.

**Course Descriptions****Lower Division****CHEM 1000 Chemistry in the Modern World (3 units)**

Basic principles of chemistry as applied to the world around us. A descriptive course designed to satisfy both the General Education requirements of the non-science student and the chemistry requirement for the subject matter preparation program leading to a multiple subject credential. Not open to students with previous college chemistry. Satisfies G.E. area B1. (Lecture, 3 hours) (Fall, Spring)

**CHEM 1002 Chemistry in the Modern World Laboratory (1 unit)**

An optional laboratory course to accompany CHEM 1000 or 3070. Experiments will illustrate some of the different types of chemistry relevant to the world we live in. These include polymers, the environment, soaps and detergents, medicinal and food chemistry. Satisfies G.E. area B1. Prerequisite: Prior or concurrent enrollment in CHEM 1000, or 3070. (Fall, Spring)

**CHEM 1100 Principles of Chemistry I (5 units)**

Fundamental principles of chemistry emphasizing atomic structure, periodic properties, theories of bonding, kinetic theory of gases, solution chemistry. Satisfies G.E. area B1. Corequisites: CHEM 1102 (laboratory) and CHEM 1104 (discussion). Prerequisite: A grade of 50 or higher on the ELM, unless exempt, or completion of MATH 0110 or its equivalent with a C or higher grade. (Lecture, 3 hours; laboratory, 3 hours; discussion, 1 hour) (CAN CHEM 2) (Fall, Spring)

**CHEM 1110 Principles of Chemistry II (5 units)**

A continuation of CHEM 1100, emphasizing gaseous and ionic equilibria, electrochemical principles, thermodynamics, radio-chemistry, and descriptive chemistry of the elements. Satisfies G.E. area B1. Corequisites: CHEM 1112 (laboratory) and CHEM 1114 (discussion). Prerequisite: CHEM 1100. (Lecture, 3 hours; laboratory, 3 hours; discussion, 1 hour) (CAN CHEM 4) (Fall, Spring)

**CHEM 2010 Quantitative Analysis and Basic Instrumental Techniques (4 units)**

Principles and practice of volumetric, gravimetric, and instrumental methods of analysis. Corequisite: CHEM 2012. Prerequisite: CHEM 1110. (Lecture, 2 hours; laboratory, 6 hours) (CAN CHEM 12) (Fall)

**CHEM 2090 Chemistry and Biochemistry for Nurses (5 units)**

Fundamental principles of chemistry and biochemistry as they relate to the nursing curriculum. This integrated lecture and laboratory course will emphasize chemistry as it relates to the human body, drugs, laboratory tests, and solutions. Satisfies G.E. area B1. Corequisite: CHEM 2092 (laboratory). Prerequisite: Passing score on ELM or exemption. (Lecture, 4 hours; laboratory, 3 hours)

**CHEM 2950 Selected Topics in Chemistry (1-5 units)**

(Topics to be specified In Class Schedule) Development of a selected branch of chemistry. Topics may vary each term. Different topics may be taken for credit. Prerequisite: Consent of instructor.

**Upper Division****CHEM 3010 Organic Chemistry I (3 units)**

Structure, properties, reactions, and stereochemistry of carbon compounds. Reaction mechanisms. Applications of spectroscopy to organic molecules. Carbohydrates, amino acids, and proteins. Concurrent enrollment or prior successful completion of CHEM 3012 is required. Prerequisite: CHEM 1110. (Lecture, 3 hours) (Fall, Spring)

**CHEM 3012 Organic Chemistry Laboratory I (1 unit)**

Basic laboratory techniques, simple organic syntheses, isolation of natural products, multi-step syntheses, gas-liquid chromatography, thin-layer chromatography, qualitative organic analysis, spectroscopic applications to structure determination. Prerequisite: CHEM 1110. (Laboratory, 3 hours) (Fall, Spring)

**CHEM 3020 Organic Chemistry II (3 units)**

Continuation of CHEM 3010. Concurrent enrollment or prior successful completion of CHEM 3022 is required. Prerequisite: CHEM 3010. (Lecture, 3 hours) (Fall, Spring)

**CHEM 3022 Organic Chemistry Laboratory II (1 unit)**

Continuation of CHEM 3012. Prerequisite: CHEM 3012. (Laboratory, 3 hours) (Fall, Spring)

**CHEM 3070 The Chemicals in Your Life (3 units)**

Basic chemical principles will be used to describe the nature of various problems and processes important to contemporary society. These would include application of chemistry in agriculture, health, the environment, and the home. Satisfies G.E. area FI. Prerequisite: Any course applicable to the General Education requirement in the sciences. (Not applicable to the major or minor in chemistry.) (Fall, Spring)

**CHEM 3090 Chemistry in the Elementary School Classroom (3 units)**

Emphasis on the principles of chemistry and the impact of chemistry on society. Students use cooperative learning projects to develop experiments and demonstrations applicable to the elementary school classroom. Designed specifically for future teachers. (LIBS Integrative: Scientific/Mathematical Inquiry) Prerequisite: Completion of lower- and upper-division science requirements for the Liberal Studies program. (Not applicable to the major or minor in Chemistry.)

**CHEM 3100 Environmental Chemistry (3 units)**

Chemical principles will be applied to the study of environmentally related processes and phenomena such as acid rain, natural water chemistry, ozone depletion, the greenhouse effect, the treatment of drinking water, waste disposal, and photochemical smog. Satisfies G.E. area FI. Prerequisite: Any course applicable to the General Education-Breadth requirement in the sciences. (Winter) (Not applicable to the major or minor in Chemistry.)

**CHEM 3170 Real World Chemistry (3 units)**

Integrates the chemical principles of environmental topics with business principles. Prerequisite: Passing score on the ELM. (Not applicable to the major or minor in Chemistry.) Satisfies G.E. area FI. One of three cluster courses in the G.E. Summit Program (The Real World: A Theatrical Work in Progress). Prerequisite: Consent of Summit Program Coordinator.

**CHEM 4010 Physical Chemistry I (3 units)**

The three laws of thermodynamics, equilibrium, critical properties of gases, osmosis, phase rule, electrochemistry, chemical kinetics, molecular structure, and spectroscopy. Prerequisites: Successful completion of CHEM 1110, one year of calculus, and one year of physics. (Lecture, 3 hours) (Spring)

**CHEM 4012 Physical Chemistry Laboratory I (1 unit)**

This laboratory accompanies CHEM 4010. Prerequisites: CHEM 2010 and 4010. Enrollment in CHEM 4010 may be concurrent.

**CHEM 4020 Physical Chemistry II (3 units)**

Continuation of CHEM 4010. Prerequisites: MATH 1420 and CHEM 4010. (Lecture, 3 hours) (Fall)

**CHEM 4021 Additional Topics in Physical Chemistry (1 unit)**

An introduction to either chemical kinetics or molecular spectroscopy, depending upon the student's interest. The course is intended for B.A. chemistry majors and others desiring a survey of either of these topics, and is not open to B.S. chemistry majors. Prerequisite: CHEM 4010. (Fall)

**CHEM 4022 Physical Chemistry Laboratory II (1 unit)**

This laboratory accompanies CHEM 4020. Prerequisites: CHEM 4012 and 4020. Enrollment in CHEM 4020 may be concurrent.

**CHEM 4100 Instrumental Analysis (4 units)**

Instrumental methods of chemical analysis including discussion of the theory and applications of nuclear magnetic resonance, electron spin resonance, mass spectroscopy, infrared, Raman, visible, ultraviolet, and atomic absorption spectroscopy; specific ion electrode methods; gas and liquid chromatography. Corequisite: CHEM 4102. Prerequisites: CHEM 2010, 3020, and 4010. (Lecture, 2 hours; laboratory, 6 hours) (Fall)

**CHEM 4200 Advanced Inorganic Chemistry (3 units)**

Atomic structure, periodic properties, theories of bonding, structure, introduction to coordination chemistry, and reactions of representative elements. Prerequisite: CHEM 4020 or consent of instructor. (Lecture, 3 hours) (Spring)

**CHEM 4212 Advanced Chemistry Laboratory (2 units)**

An advanced level course involving modern synthetic and instrumental techniques with an emphasis on inorganic chemistry. Prerequisites: CHEM 4020, 4100, and concurrent enrollment in CHEM 4200. (Spring)

**CHEM 4300 Advanced Organic Chemistry (3 units)**

Chemical kinetics, structure-reactivity relationships, molecular orbital theory, orbital symmetry, reactive intermediates, rearrangements and neighboring group effects; nucleophilic aliphatic substitution, photochemistry. Prerequisite: CHEM 3020. (Lecture, 3 hours) (Spring, alternate years)

**CHEM 4400 Biochemistry I (3 units)**

Basic chemistry of proteins, nucleic acids, and lipids. Introductory enzymology and biochemical thermodynamics will also be included. Prerequisite: CHEM 3020. (Fall)

**CHEM 4402 Biochemistry Laboratory I (1 unit)**

An introduction to biochemical techniques including chromatography, purification of biological molecules, spectrophotometry, and fluorimetry. Prerequisite: CHEM 4400 or concurrent enrollment. (Laboratory, 3 hours). (Fall)

**CHEM 4420 Biochemistry II (WP) (3 units)**

An in-depth continuation of CHEM 4400. Additional topics will include anabolic and catabolic pathways of carbohydrate, protein, and lipid metabolism. Satisfies upper-division writing proficiency requirement. Prerequisite: Completion of the Writing Proficiency Screening Test with a passing score and CHEM 4400. (Spring)

**CHEM 4610 Computer Methods in Chemistry (2 units)**

Computer-based methods applied to problems in chemistry. Corequisite: CHEM 4612. Prerequisites: CHEM 2010, MATH 1420, and CS 1500, or equivalent. (Lecture, 1 hour; laboratory, 2 hours). (Winter, alternate years)

**CHEM 4910 Cooperative Education (2-4 units)**

Provides an opportunity to acquire relevant, practical experience in supervised paid employment within the discipline. Students are placed in private or public sector positions under the supervision of the employer and departmental Co-op coordinator. May be repeated for a total of 8 units. Prerequisites: Sophomore standing; CHEM 2010, 3020, 3022, and consent of the department's Co-op Coordinator. (Fall, Spring)

**CHEM 4940 Chemistry Internship (2-4 units)**

Designed for students in chemistry who wish to apply their educational experience to a practical situation in a public or private agency. Prerequisites: CHEM 2010, 3020, 3022 and consent of Department Internship Coordinator. (Fall, Winter, Spring)

**CHEM 4950 Selected Topics in Chemistry (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of chemistry. Topics vary each term. Different topics may be taken for credit. Corequisite: CHEM 4953. Prerequisite: Consent of instructor.

**CHEM 4960 Research Seminar (1 unit)**

The presentation of research results or topical literature surveys by students and visiting scientists. May be repeated for a total of 2 units. Prerequisite: CHEM 3010 or consent of instructor. (Spring)

**CHEM 4961 Seminar on Directed Readings (1 unit)**

The presentation and discussion by students of research papers taken from the current chemical literature. Prerequisite: Consent of instructor. (Spring)

**CHEM 4980 Individual Study (1-4 units)**

For qualified students desiring to do research or to pursue the study of some specialized topic. May be repeated for a total of 6 units. Prerequisite: Consent of instructor. (Fall, Winter, Spring)

**Department of Computer Science**

Thomas J. Carter, Ph.D., *Chair*

**Professors:** Carter, Sarraille

**Associate Professor:** Silverman

**Assistant Professors:** Thomas, M., Martin

Office: Demergasso-Bava Hall — DBH 287

Phone: (209) 667-3185

**Bachelor of Science in Computer Science  
Minor in Computer Science****Bachelor of Science in Computer Science****Requirements**

1. Complete University General Education requirements for a Bachelor of Arts or Bachelor of Science degree (51 units minimum).
2. Complete the prerequisites to the major. No more than 8 units of CR-graded coursework may apply toward the prerequisites to the major.
3. Complete the major of not less than 37 upper-division units.
4. Complete one upper-division course in Chemistry or Physics/Physical Sciences (3-4 units)
5. Complete PHIL 4401 Professional Ethics, 3 units.
6. Satisfy the Departmental Writing Proficiency requirement.

*Note: No upper-division course which applies to the major or to the electives may be taken on a CR-graded basis except CS 4910 (Cooperative Education), CS 4940 (Practicum in Computer Science), and CS 4960 (Seminar in Computer Science). Prerequisites to the major are expected to be completed before upper-division computer science courses are taken. Completion of a minor is not required.*

**Departmental Writing Proficiency Requirement**

1. Pass the university-wide Writing Proficiency Screening Test (or have the equivalent transferred from another campus).
2. Pass a Computer Science course with a WP designation, or obtain certification from the departmental WVP coordinator.

**Prerequisites to the Major**

CS 1500 Computer Programming I, 3 units

CS 2500 Computer Programming II, 3 units

CS 2700 Assembly Language and Computer Architecture, 3 units

MATH 1410 Calculus I, 4 units

MATH 1420 Calculus II, 4 units

MATH 1620 Probability and Statistics, 4 units

MATH 2300 Discrete Structures, 3 units

MATH 2530 Linear Algebra, 3 units

And either of these sequences:

PHYS 2250, 2260 General Physics I, II with labs, 10 units, **or**  
CHEM 1100, 1110 Principles of Chemistry I, II, 10 units

### The Major (37 units)

1. Complete the following required courses (16 units):
  - CS 3050 File Processing, 3 units
  - CS 3100 Data Structures and Algorithms, 3 units
  - CS 3740 Computer Organization, 3 units
  - CS 3750 Operating Systems I, 3 units
  - CS 4100 Programming Languages (W/P), 3 units
  - CS 4960 Seminar in Computer Science, 1 unit
2. Depth Requirement (9 units). Complete three of the following:
  - CS 4300 Compiler Theory, 3 units
  - CS 4410 Automata, Computability, and Formal Languages, 3 units
  - CS 4440 Theory of Algorithms, 3 units
  - CS 4480 Artificial Intelligence, 3 units
  - CS 4800 Software Engineering, 3 units
3. Select 12 units from the following courses. A course may not be used as an elective if it is used to satisfy the depth requirement; at least 9 units must be in computer science courses. Units from CS 4910, CS 4940, and CS 4950 may be used with prior departmental approval.
  - CS 3000 Communication Networks, 3 units
  - CS 3150 Nonlinear Systems and Chaos, 3 units
  - CS 3200 Computer Simulation Techniques, 3 units
  - CS 3600 Computer Graphics I, 3 units
  - CS 3850 Object Oriented Programming, 3 units
  - CS 4250 Database Management Systems, 3 units
  - CS 4270 Ecommerce Systems Design, 3 units
  - CS 4300 Compiler Theory, 3 units
  - CS 4410 Automata, Computability, and Formal Languages, 3 units
  - CS 4440 Theory of Algorithms, 3 units
  - CS 4450 Coding and Information Theory, 3 units
  - CS 4480 Artificial Intelligence, 3 units
  - CS 4600 Computer Graphics II, 3 units
  - CS 4750 Operating Systems II, 3 units
  - CS 4800 Software Engineering, 3 units
  - CS 4980 Individual Study, 1–4 units
  - CIS 4770 Systems Analysis and Design, 3 units
  - MATH 4330 Numerical Analysis, 3 units
  - MATH 4530 Abstract Algebra, 3 units
  - PHYS 4250 Analog and Digital Electronics, 4 units

### Minor in Computer Science

Complete 24 units of computer science coursework from the courses listed below to include a minimum of 9 upper-division units:

1. Complete the following lower-division courses:
  - CS 1500 Computer Programming I, 3 units
  - CS 2500 Computer Programming II, 3 units
  - CS 2700 Assembly Language and Computer Architecture, 3 units
 One of the following year sequence of courses (6-8 units):
  - MATH 1410, 1420 Calculus I, II, 8 units
  - MATH 1910, 1920 Calculus with Applications I, II, 6 units
2. Select a minimum of 9 upper-division units as outlined below:
  - CS 3050 File Processing, 3 units
  - CS 3100 Data Structures and Algorithms, 3 units
  - One upper-division CS course as approved by an adviser, 3 units

### Learning Objectives

Students will gain a strong foundation in:

- the elements of physical science (physics or chemistry)
- general problem-solving skills, and implementing solutions as computer programs
- college-level mathematics including calculus, statistics, and linear algebra
- mathematical topics specifically relevant to computer science (discrete mathematics)
- machine-level hardware/architecture and assembly language programming.

Students will demonstrate a foundational understanding of:

- external (file system) data storage systems and algorithms
- internal data structures, associated algorithms, and analytic techniques concerning such data structures and algorithms
- ethical issues affecting professionals working in technical and other fields
- computer operating system principles and associated algorithms and implementation issues

Students will demonstrate an in-depth understanding of:

- computer system organization principles and techniques
- principles of computer programming languages, and associated algorithms and techniques
- several important areas of computer science, including some of the more theoretical aspects of the field

Students will achieve a broad exposure to:

- a variety of more advanced topics in computer science.
- upper-division level explorations in the physical sciences

Students will be able to write clearly and effectively about a topic within the discipline, with language and style appropriate to the discipline.

Students will be able to use the knowledge and skills developed throughout the degree program to do individual exploration of a specific topic in computer sciences, and to provide an oral and written presentation of this material to an audience.

## Course Descriptions

### Lower Division

#### **CS 1000 Introduction to Computers (3 units)**

Introduction to the computer for the non-Computer Science major. Selected computer applications, beginning programming, review of hardware and software, social impact of computing, and the future of the computer. Use of microcomputers. Corequisite: CS 1002. (Lecture, 2 hours; laboratory, 2 hours) (Fall, Spring)

#### **CS 1020 Elements of Computing (1 unit)**

Introduction to the computer for the non-computer science major. Selected computer applications, review of hardware and software components of a computer, social impact of computing, and the future of the computer. Use of personal computers, particularly effective use of common tools like word processors and spreadsheets. Enrollment preference will be given to CAMP program participants. Freshman only. (Lecture, 1 hour) (Fall)

#### **CS 1500 Computer Programming I (3 units)**

The usual entry course for Computer Science majors. Algorithm development and problem-solving methods. Design and development of computer programs using a structured programming language such as C++. Corequisite: CS 1502. Prerequisite: Two years of high school algebra. (Lecture, 2 hours; laboratory, 2 hours) (Fall, Spring)

#### **CS 2000 Effective Computing (3 units)**

To familiarize students with current computing technologies used within education, home, and business environments. Topics include productivity tools such as word processing, spreadsheets, hardware, and operating systems. There also will be discussion of ethical and social issues concerning information technologies. Enrollment preference will be given to Liberal Studies majors. Satisfies G.E. area E1. Students may not use both CS 2000 and CS 4000 to satisfy G.E. requirements. Corequisite: CS 2002. (Credit may not be given for both CS 2000 and CS 4000.) (Lecture, 2 hours; laboratory, 2 hours)

#### **CS 2500 Computer Programming II (3 units)**

Continued development of discipline in program design, in style and expression, and in debugging and testing, especially for larger programs. Introduction to algorithmic analysis, string processing, recursion, internal search/sort methods, and simple data structures. Introduction to professional methodologies and ethics. Corequisite: CS 2502. Prerequisite: CS 1500. (Lecture, 2 hours; laboratory, 2 hours) (Fall, Spring)

#### **CS 2700 Assembly Language and Computer Architecture (3 units)**

Computer programming at the machine level. Machine language and basic machine architecture, addressing modes, subprogram linkage, program sectioning and overlays, I/O programming, macros, and interrupts. Corequisite: CS 2702. Prerequisite: CS 2500. (Lecture, 2 hours; laboratory, 2 hours) (Fall)

### Upper Division

#### **CS 3000 Communication Networks (3 units)**

Introduction to the operation of computer networks. Communication standards and protocols, network layers, data and packet transmission, internetworking, network applications, emerging technologies, software monitoring tools, social and ethical issues. Corequisite: CS 3002. Prerequisite: CS 2500 (Lecture, 2 hours; laboratory, 2 hours)

#### **CS 3050 File Processing (3 units)**

Study of the physical and logical characteristics of data stored on external storage devices. Data structures used to organize such information. Access methods and details of working with file systems. Corequisite: CS 3052. Prerequisite: CS 2500. (Lecture, 2 hours; laboratory, 2 hours) (Fall)

#### **CS 3100 Data Structures and Algorithms (3 units)**

Fundamental concepts and abstraction of data structures. The design and analysis of algorithms involving such data structures as arrays, stacks, queues, lists, trees, strings, graphs, and files. Techniques for estimating the time and memory requirements of computer programs. Several large programming assignments. Prerequisite: CS 2500. (Fall, Spring)

#### **CS 3150 Nonlinear Systems and Chaos (3 units)**

(Same as COGS 3150) Addresses theoretical and quantitative methods useful for work with nonlinear systems from many fields. Together with its laboratory, the course provides experience with phase space maps, Poincare sections, basins of attraction, strange attractors, and fractals and fractal dimensionality. Emphasizes systems best described by discrete math. Examples are drawn from physics, biology, cognitive science, economics, and other areas. Corequisite: CS 3152. Prerequisite: COGS 2300 or consent of instructor. (Lecture, 2 hours; laboratory, 2 hours).

#### **CS 3200 Computer Simulation Techniques (3 units)**

Introduction to simulation, planning computer simulation experiments, simulation models. Simulation methodology, design of experiments, analysis of data validation of models and results. Programming selected applications using simulation languages such as GPSS or simscript. Corequisite: CS 3202. Prerequisites: MATH 1600 or 1610 or 1620 ECON 3205, and CS 1500 or CIS 2010. (Lecture, 2 hours; laboratory, 2 hours) (Spring)

#### **CS 3600 Computer Graphics I (3 units)**

Introduction to computer graphics programming using a current graphics API with emphasis on the use of computer graphics in the sciences and mathematics. Course includes modeling, rendering, animation, interaction, and realism. Corequisite: CS 3602. Prerequisite: CS 2500 (Lecture, 2 hours; laboratory, 2 hours) (Fall)

**CS 3740 Computer Organization (3 units)**

Overview of logical hardware technologies used in digital computer systems, including memory organization, bus structures, CPU pipelining and parallelism, and control unit organization. Prerequisite: CS 2700. (Spring)

**CS 3750 Operating Systems I (3 units)**

Introduction to computer operating system design and implementation issues. Historical development of operating systems; management of processes, concurrent processes, storage, and I/O systems; distributed operating systems; protection and security; ethical issues relating to security and privacy; and case studies of operating systems. Corequisite: CS 3752. Prerequisites: CS 3100 and CS 3740. (Lecture, 2 hours; laboratory, 2 hours) (Fall)

**CS 3850 Object Oriented Programming (3 units)**

Presents the most important object-oriented features of a computer programming language such as C++. Emphasis on effective use of the paradigm. Counts for Computer Science elective credit. Corequisite: CS 3852. Prerequisite: CS 2500 or consent of instructor.

**CS 4000 Personal Computing (3 units)**

Gives the student the knowledge and experience needed to use a personal computer effectively. A range of computers and software will be available; as much as possible, the student will be able to learn about systems which are directly usable in his or her area of study. Topics include discussions of computer hardware, the range of capabilities of the personal computer, how to evaluate a piece of software, and how software is written. Satisfies G.E. area FI. Students may not use both CS 2000 and CS 4000 to satisfy G.E. requirements. Corequisite: CS 4002. Prerequisite: Upper-division standing. (Credit may not be given for both CS 2000 and CS 4000.) (Lecture, 2 hours; laboratory, 2 hours) (Fall, Winter, Spring)

**CS 4100 Programming Languages (WP) (3 units)**

Study of programming language concepts such as binding, data structures, string handling, control structures, as embodied in various programming languages. Satisfies upper-division writing proficiency requirement. Prerequisites: Completion of the Writing Proficiency Screening Test with a passing score and CS 3100. (Spring)

**CS 4250 Database Management Systems (3 units)**

Modeling, development, and implementation of database systems using storage structures, data definition languages, and data manipulation languages for the relational approach to database management. Database integrity and security problems. Historical development of database systems. Corequisite: CS 4252. Prerequisites: CS 3050 and 3100. (Lecture, 2 hours; laboratory, 2 hours) (Spring)

**CS 4270 Ecommerce Systems Design (3 units)**

Study of technologies and architectures of large, complex, and robust Ecommerce Systems. Discussion of the design and implementation of major subsystems of Ecommerce Systems. Topics: Java and OO design, n-tier architectures, DB access, Java Servlets, and a significant project. Corequisite: CS 4272. Prerequisites: CS 3050 and basic Java. (Lecture, 2 hours; laboratory, 2 hours)

**CS 4300 Compiler Theory (3 units)**

Lexical, syntactic, and semantic analyses and syntax directed translation of programming languages. Includes symbol table construction, error diagnostics, and code generation. Corequisite: CS 4302. Prerequisite: CS 4100. (Lecture, 2 hours; laboratory, 2 hours) (Fall)

**CS 4410 Automata, Computability, and Formal Languages (3 units)**

Finite state concepts; sequential machines and state minimization; Chomsky grammar; algorithms on grammars; computability and Turing machines; non-computable functions. Prerequisite: CS 4100. (Spring)

**CS 4440 Theory of Algorithms (3 units)**

A systematic study of the design and efficiency analysis of algorithms. Coverage of fundamental techniques of algorithms such as greedy, divide-and-conquer, dynamic programming, graph techniques, probabilistic, and parallel. An introduction to computational complexity theory: problem reduction, NP-complete problems, and other complexity classes. Prerequisites: CS 3100 and MATH 2300. (Spring)

**CS 4450 Coding and Information Theory (3 units)**

Topics to be selected from error detecting and correcting codes, encryption and decryption techniques, RSA and knapsack codes, algebraic coding theory, Hamming distance, sphere packing and its relation to optimal codes, Hamming, Huffman and Gray codes, entropy, channel capacity and Shannon's theorem, bandwidth and the sampling theorem. Prerequisite: CS 3100 or MATH 2300 or equivalent. (Fall)

**CS 4480 Artificial Intelligence (3 units)**

Notational systems, structures, and strategies for their choice; search strategies; parallel vs. serial processing; communication and perception; applications in psychology, medicine, and robotics. Prerequisite: CS 3100.

**CS 4600 Computer Graphics II (3 units)**

Computer graphics algorithms and techniques, implementing the graphics techniques used in CS 3600. Projections and transformations, color models, polygon interpolation, advanced splines, ray tracing, volume rendering, and various specialized techniques. Prerequisites: CS 3600; MATH 2530 or equivalent is recommended. (Spring)

**CS 4750 Operating Systems II (3 units)**

(Formerly CS 3760) A study of operating systems theory, design, and implementation. Topics may include kernel internals; distributed systems; experimental systems; system programming, generation, and configuration; process coordination; and protection and security. Corequisite: CS 4752. Prerequisite: CS 3750. (Lecture, 2 hours; laboratory, 2 hours) (Spring)

**CS 4800 Software Engineering (3 units)**

(Formerly CS 3800) Introduction to formal techniques in software design, development, and verification. The students will form teams. Each team will design a significant software project. Corequisite: CS 4802. Prerequisites: CS 3050 and 3100. (Lecture, 2 hours; laboratory, 2 hours) (Fall)

**CS 4910 Cooperative Education (1-3 units)**

An opportunity to acquire relevant practical experience in supervised paid employment within the discipline. Students are placed in private or public sector positions under the supervision of the employer and a departmental coordinator. May be repeated for a total of six units. Prerequisites: Sophomore standing and consent of coordinator.

**CS 4940 Practicum in Computer Science (1-3 units)**

Practical experience through directed work with department faculty/staff to extend coursework knowledge. May be repeated for a total of six units. Prerequisites: Upper-division standing and consent of instructor.

**CS 4950 Selected Topics in Computer Science (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of computer science. Topics vary each term. Different topics may be taken for a maximum of 6 units. Prerequisites: Senior standing and consent of instructor.

**CS 4951 Selected Topics in Computer Science (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of computer science. Topics vary each term. Different topics may be taken for a maximum of 6 units. Corequisite: CS 4953. Prerequisites: Senior standing and consent of instructor.

**CS 4960 Seminar in Computer Science (1 unit)**

Presentation and discussion of selected topics in computer science from the current literature. Prerequisites: Senior standing and consent of instructor. (Spring)

**CS 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisite: Consent of instructor.

## Department of Mathematics

Viji K. Sundar, Ph.D., *Chair*

**Professors:** Abram, Clarke, Fazal, Feldman, Reneau, Sundar

**Associate Professor:** Jue

**Assistant Professors:** Bice, Coughlin, An, Hoover, Rock

**Lecturers:** Moore, Poole, S., Mitchell

Office: Demergasso-Bava Hall — DBH264

Phone: (209) 667-3461

**Bachelor of Arts in Mathematics**

**Bachelor of Science in Mathematics**

**Bachelor of Arts in Mathematics with Mathematics Subject Matter Preparation Program**

**Liberal Studies degree concentration in Mathematics**

The degree programs presuppose seven semesters of high school level mathematics: algebra (2 years), plane geometry (1 year), and trigonometry (1/2 year); solid geometry and physics are desirable. Deficiencies may be made up by proper selection of courses in the lower division. Recommended courses in lower-division supporting fields are one year of computer science, or economic theory, or general physics with calculus.

Courses in mathematical computing, mathematics, operations research and statistics are designed to provide quality undergraduate training in the mathematical sciences and to serve the needs of majors in mathematics, the natural and social sciences, and other fields. The degree programs of the Department of Mathematics provide preparation for various careers in the mathematical sciences.

## Bachelor of Arts or Bachelor of Science in Mathematics

**Requirements**

1. Complete University General Education Breadth Requirements for a baccalaureate degree (51 units minimum).
2. Complete the following prerequisites to the major (21, 24, or 26 units):
  - MATH 1410, 1420 Calculus, I, II, 8 units
  - MATH 1620 Probability and Statistics, 4 units
  - MATH 2410 Multivariate Calculus, 4 units
  - MATH 2460 Introduction to Differential Equations, 2 units
  - MATH 2530 Linear Algebra, 3 units

Bachelor of Arts in Mathematics with the Mathematics Subject Matter Preparation Program (SMPP) also requires completion of:

CS 1500/1502 Computer Programming I and Lab, 3 units

MATH 1412 Calculus I Laboratory, 1 unit

MATH 1422 Calculus II Laboratory, 1 unit

Bachelor of Science in Mathematics also requires completion of:

CS 1500/1502 Computer Programming I and Lab, 3 units

3. Complete the major of not less than 30 upper-division units in mathematics. All courses which apply to the major must be completed with a grade of C– or better.
4. Complete the following upper-division courses and units for the desired degree program:
  - a. Bachelor of Arts (without the Mathematics Subject Matter Preparation Program)
    - i. Complete the following courses (18 units):
      - MATH 3400 Set Theory and Logic, 3 units
      - MATH 3600 Theory of Numbers, 3 units
      - MATH 4130 Real Analysis I, 3 units
      - MATH 4140 Real Analysis II, 3 units
      - MATH 4530 Abstract Algebra, 3 units
      - MATH 4600 Complex Variables, 3 units

- ii. Complete two of the following courses (6 units):  
 MATH 3230 Differential Equations, 3 units  
 MATH 4330 Numerical Analysis, 3 units  
 MATH 4430 Operations Research, 3 units  
 MATH 4630 Probability Theory, 3 units
- iii. Complete selected upper-division courses as approved by the major adviser so the total upper-division units in mathematics is 30 (6 elective units).
- b. Bachelor of Arts with the Mathematics Subject Matter Preparation Program
  - i. Complete the following courses (28 units):  
 MATH 3060 Modern Geometry, 3 units  
 MATH 3110 History of Mathematics, 3 units  
 MATH 3400 Set Theory and Logic, 3 units  
 MATH 3600 Theory of Numbers, 3 units  
 MATH 4020 Mathematics for Secondary Teachers, 3 units  
 MATH 4022 Mathematics for Secondary Teachers Laboratory, 1 unit  
 MATH 4130 Real Analysis I, 3 units  
 MATH 4530 Abstract Algebra, 3 units  
 MATH 4630 Probability Theory, 3 units  
 MATH 4960 Senior Seminar in Mathematics (VWP), 3 units
  - ii. One elective selected from the following (3 units):  
 MATH 3230 Differential Equations, 3 units  
 MATH 4330 Numerical Analysis, 3 units  
 MATH 4430 Operations Research, 3 units  
 MATH 4600 Complex Variables, 3 units
- c. Bachelor of Science in Mathematics
  - i. Complete the following courses (24 units):  
 MATH 3230 Differential Equations, 3 units  
 MATH 3400 Set Theory and Logic, 3 units  
 MATH 4130 Real Analysis I, 3 units  
 MATH 4330 Numerical Analysis, 3 units  
 MATH 4430 Operations Research, 3 units  
 MATH 4530 Abstract Algebra, 3 units  
 MATH 4600 Complex Variables, 3 units  
 MATH 4630 Probability Theory, 3 units
  - ii. Complete selected upper-division courses as approved by the major adviser so the total upper-division units in mathematics is 30 (6 elective units)
- 5. The following are strongly recommended for all mathematics majors:
  - a. Satisfy the university upper-division writing proficiency requirement by completing MATH 4960 Senior Seminar in Mathematics.
  - b. Depending on the student's interest and professional objectives, complete one of the following sequences of courses outside the discipline of mathematics:  
 CS 1500, 2500 Computer Programming I, II, 6 units  
 ECON 2500, 2510 Principles of Macroeconomics,  
       Principles of Microeconomics, 6 units  
 PHYS 2250, 2260 General Physics I, II, 8 units

### Mathematics Subject Matter Preparation Program

*Fulfills subject matter competency prerequisite for entrance into a credential program for a single subject teaching credential in mathematics.*

Complete the following courses and other requirements:

1. Core (36 units):  
 MATH 1410 Calculus I, 4 units  
 MATH 1420 Calculus II, 4 units  
 MATH 1620 Probability and Statistics, 4 units  
 MATH 2410 Multivariate Calculus, 4 units  
 MATH 2460 Introduction to Differential Equations, 2 units  
 MATH 2530 Linear Algebra, 3 units  
 MATH 3060 Modern Geometry, 3 units  
 MATH 3110 History of Mathematics, 3 units  
 MATH 3400 Set Theory and Logic, 3 units  
 MATH 3600 Theory of Numbers, 3 units  
 MATH 4530 Abstract Algebra, 3 units
2. Breadth and Perspective (21 units):  
 CS 1500/1502 Computer Programming I and Lab, 3 units  
 MATH 1412 Calculus I Laboratory, 1 unit  
 MATH 1422 Calculus II Laboratory, 1 unit  
 MATH 4020 Mathematics for Secondary Teachers, 3 units  
 MATH 4022 Mathematics for Secondary Teachers Laboratory, 1 unit  
 MATH 4130 Real Analysis I, 3 units  
 MATH 4630 Probability Theory, 3 units  
 MATH 4960 Senior Seminar in Mathematics (VWP), 3 units  
 One elective selected from the following:  
 MATH 3230 Differential Equations, 3 units  
 MATH 4330 Numerical Analysis, 3 units  
 MATH 4430 Operations Research, 3 units  
 MATH 4600 Complex Variables, 3 units
3. Other Requirements:  
 A student must meet specified academic standards to obtain department certification for having completed the Mathematics Subject Matter Preparation Program. A brochure describing the program is available from the Department of Mathematics.



**Minor in Mathematics****Requirements** (20 units)

1. Complete MATH 1410, 1420 Calculus I, II, 8 units
2. Select upper-division courses in mathematics as approved by the minor adviser, for a minimum of 12 units.

**Liberal Studies Concentration in Mathematics**

Please refer to the Liberal Studies section of this catalog.

**Teaching Credentials**

Majors in mathematics interested in multiple subject or single subject credentials are referred to the College of Education section of the Graduate Catalog for a description of teaching credential programs. Students may fulfill the subject matter prerequisites to enter a teaching credential program to obtain a single subject teaching credential in mathematics by completing the Mathematics Subject Matter Preparation Program previously described.

**Learning Objectives**

Students will be able to:

- Use problem-solving techniques to solve both standard and nonstandard mathematical problems.
- Use mathematical models to represent and solve real-world problems.
- Use appropriate technology for solving mathematical problems.
- Apply mathematical reasoning in solving complex problems.
- Develop enthusiasm and an appreciation for studying and applying mathematics.
- Read and write mathematical proofs.
- Effectively communicate mathematical concepts in written and oral form.
- Demonstrate understanding of the theory, techniques, and applications of calculus and differential equations, linear algebra, geometry, statistics, and abstract algebra.

In addition, students in the Subject Matter Preparation Program (SMPP) will be able to:

- Explain, using a multitude of methods, mathematical concepts taught in secondary education.
- Make written and oral presentations explaining mathematical concepts, ideas, and techniques.

**Course Descriptions****Prebaccalaureate**

*Note: Courses numbered 0001-0999 are prebaccalaureate level and do not carry unit credit toward the 120 units required for a bachelor's degree.*

**MATH 0103 Pre- and Beginning Algebra (4 units)**

Uses methods and strategies that have been designed to enhance student success in the course. Transition from arithmetic to algebra; operations on real numbers and algebraic expressions; polynomials, rational expressions, square roots; solving elementary equations and word problems. Satisfactory completion of this course fulfills the prerequisite for MATH 0106. Credit earned does not count toward unit requirements for graduation, for general education, or for any major. Four lecture hours per week, utilizing directed learning activities. Prerequisite: ELM score between 0 and 32.

**MATH 0106 Intermediate Algebra for Non-Science/Math (4 units)**

Uses methods and strategies that have been designed to enhance student success. Introduction to the basic properties of arithmetic, real numbers, variables, equations, algebraic expressions, functions, and their graphs. Includes evaluation of expressions and formulas; translation from words to symbols; solutions of linear equations and inequalities; absolute value; powers and roots; solving two linear equations in two unknowns; applications. Prerequisite: MATH 0103 or ELM score between 34 and 48, inclusive, or equivalent. Credit earned does not count toward unit requirements for graduation, for general education, or for any major. Four lecture hours per week, utilizing directed learning activities. Primarily for business, social science, humanities, fine arts, and undecided-major students.

**MATH 0110 Intermediate Algebra for Math/Science (4 units)**

Fundamental operations, laws, terminology, and notation of algebra; concepts of expression, set, variable, function, graph, equality, equations, and identity; drill with fractions, exponents, and radicals; linear and quadratic equations; systems of equations; introduction to logarithms; introduction to functions, including function notation, polynomial functions, rational functions, exponential, and logarithmic functions; introduction to conic sections. Prerequisite: MATH 0106 or ELM score between 34 and 48 inclusive, or equivalent. Credit earned does not count toward unit requirements for graduation, for general education, or for any major. Four lecture hours per week, utilizing directed learning activities. Primarily for science, math, and technology-oriented students.

**Lower Division****MATH 1000 Excursions into Mathematics (3 units)**

An introductory course which provides an overview of contemporary mathematics for students who have no technical background. Emphasizes mathematics as used in real life problems. Topics may be selected from the areas of elementary number theory, metric system, geometry, probability, statistics, power of the pocket calculator, and computers. Satisfies G.E. area B3. Prerequisite: MATH 0106, or 0110, or a passing score on the ELM test, or equivalent. (CAN MATH 2)

**MATH 1030 Elementary Foundations of Mathematics I (3 units)**

Elementary set theory, number systems, properties of real numbers, solutions of equations, and inequalities. Recommended for students seeking a multiple subject teaching credential. Satisfies G.E. area B3. Prerequisite: MATH 0106, or 0110, or a passing score on the ELM test, or equivalent. (CAN MATH 4)

**MATH 1040 Elementary Foundations of Mathematics II (3 units)**

Continuation of MATH 1030. Functions and graphs, elementary probability and statistics, Euclidean geometry, measure, and introduction to analytic geometry. Recommended for students seeking a multiple subject teaching credential. Prerequisite: MATH 1030 with a grade of C– or better.

**MATH 1070 College Algebra (3 units)**

Review of basic algebraic topics and basic analytic geometry, complex numbers, functional notation, graphs, polynomials and rational functions, exponential and logarithmic functions, systems of equations, and conic sections. Satisfies G.E. area B3. Prerequisite: MATH 0106, or 0110 (MATH 0110 strongly recommended), or a passing score on the ELM test, or equivalent.

**MATH 1080 Trigonometry (3 units)**

Angles, trigonometry of right triangles, trigonometric functions of real numbers, trigonometric identities, trigonometric equations, inverse trigonometric functions, law of sines, law of cosines, polar coordinates, and selected applications. Satisfies G.E. area B3. Prerequisite: MATH 1070 with a grade of C– or better or a passing score on the Trigonometry/Precalculus Screening Test.

**MATH 1092 Graphing Calculator Laboratory (1 unit)**

Advanced problem solving and collaborative learning utilizing graphing calculators. Instruction and demonstrations will be done with the TI-83 Plus calculator; students may use other comparable graphing calculators. Problems will be taken from first year mathematics, chemistry, biology, and other quantitative areas of study, utilizing directed learning activities.

**MATH 1100 Precalculus (4 units)**

Introduction to analytic geometry, functions, circular and trigonometric functions, trigonometric identities, transcendental functions, and complex numbers. Satisfies G.E. area B3. Prerequisites: MATH 0106, or 0110 (MATH 0110 strongly recommended), or a passing score on the ELM test or equivalent or a passing score on the Trigonometry/Precalculus Screening Test. (CAN MATH 16)

**MATH 1410 Calculus I (4 units)**

Inequalities, functions and graphs, limits and continuity, the derivative, differentiation of algebraic and trigonometric functions, applications of differentiation, the definite integral, and applications of the definite integral. Satisfies G.E. area B3. Prerequisite: MATH 1080 or 1100 with a grade of C– or better. (CAN MATH 18)

**MATH 1412 Calculus I Laboratory (1 unit)**

Advanced problem-solving and collaborative learning in Calculus I mathematics. To receive credit, students must attend one of the 2-hour sessions each week. Prerequisite: MATH 1410 with a grade of C– or better or concurrent enrollment in MATH 1410.

**MATH 1420 Calculus II (4 units)**

Exponential functions, parametric equations, thorough techniques of integration, applications of the definite integral, introduction to first order ordinary differential equations, L'Hôpital's rules, and infinite series. Prerequisite: MATH 1410 with a grade of C– or better. (CAN MATH 20)

**MATH 1422 Calculus II Laboratory (1 unit)**

Advanced problem-solving and collaborative learning in Calculus II mathematics. To receive credit, students must attend one of the 2-hour sessions each week. Prerequisite: MATH 1420 with a grade of C– or better or concurrent enrollment in MATH 1420.

**MATH 1500 Finite Mathematics (3 units)**

Counting processes, elementary probability, systems of linear equations and inequalities, matrices, linear programming, simplex method, Markov chains, selected applications. Satisfies G.E. area B3. Prerequisite: MATH 0106, or 0110, or passing score on the ELM examination, or equivalent. (CAN MATH 12)

**MATH 1600 Statistics (4 units)**

Introductory course designed for students in the behavioral, biological, and social sciences. The description of sample data, probability and probability distributions, sampling and estimation, testing hypotheses, correlation and regression, introduction to analysis of variance. Satisfies G.E. area B3. Corequisite: MATH 1602. Prerequisite: MATH 0106, or 0110, or a passing score on the ELM test, or equivalent (Lecture, 3 hours; laboratory, 2 hours) (CAN STAT 2)

**MATH 1610 Statistics for Decision Making (3 units)**

Introductory course for students in business administration. Data summarization, review of probability distributions, estimation, hypothesis testing, correlation, regression. May use statistical computer packages. Satisfies G.E. area B3. Prerequisite: MATH 0106, or 0110, or a passing score on the ELM test, or equivalent.

**MATH 1620 Probability and Statistics (4 units)**

Introductory course for mathematics and computer science majors. Combinatorics, probability and random variables, descriptive statistics, estimation, hypothesis testing, and correlation and regression. Use of computers for simulation and statistical analysis. Prerequisite: MATH 1410 with a grade of C– or better.

**MATH 1910 Calculus with Applications I (3 units)**

The fundamental concepts of calculus and their applications to problems in the behavioral, biological, chemical, decision, and social sciences will be introduced. Functions, graphs, limits, the derivative, and definite integral. Not open to students who are seeking a Bachelor of Arts degree in mathematics, or physics; nor is it open to students seeking a Bachelor of Science degree in chemistry, physics, or mathematics. Satisfies G.E. area B3. Prerequisite: MATH 0106, or 0110 (MATH 0110 strongly recommended), or a passing score on the ELM test, or equivalent. (CAN MATH 30)

**MATH 1920 Calculus with Applications II (3 units)**

Fundamental concepts of calculus and their applications to problems in the behavioral, biological, chemical, decision, and social sciences will be introduced. Logarithmic and exponential functions, trigonometric functions, techniques of integration, applications of the definite integral, and introduction to calculus in higher dimensions. Not open to students seeking a Bachelor of Arts degree in mathematics or physics; nor is it open to students seeking a Bachelor of Science degree in chemistry, physics, or mathematics. Prerequisite: MATH 1910 or 1410 with a grade of C– or better. (CAN MATH 32)

**MATH 2300 Discrete Structures (3 units)**

(Formerly MATH 3500) Discrete mathematical structures and their application in computer science. Sets, logic, proof, relations, and functions. Topics selected from combinatorics, recurrence equations, and graph theory. Prerequisite: MATH 1100 or both MATH 1070 and MATH 1080 with a grade of C– or better.

**MATH 2410 Multivariate Calculus (4 units)**

Vectors in three dimensions, solid analytic geometry, partial differentiation, multiple integration, differentiation under the integral sign, and vector field theory. Prerequisite: MATH 1420 with a grade of C– or better. (CAN MATH 22)

**MATH 2460 Introduction to Differential Equations (2 units)**

First order differential equations, second order linear differential equations with constant coefficients, power series solutions, and selected applications. Prerequisite: MATH 2410 with a grade of C– or better or consent of instructor.

**MATH 2530 Linear Algebra (3 units)**

Linear equations and matrices, vector spaces, inner product spaces, linear transformations, determinants, eigenvalues and eigenvectors, and selected applications. Prerequisite: MATH 1420 with a grade of C– or better or consent of instructor. (CAN MATH 26)

**MATH 2670 Linear and Abstract Algebra for Teachers (4 units)**

Covers California Subject Matter Requirements in linear and abstract algebra, including algebra of vectors and matrices and building blocks in abstract algebra (emphasizing groups and extending to rings and fields). Prerequisite: MATH 1070 with a grade of C or better.

**MATH 2950 Selected Topics in Mathematics (1-5 units)**

(Topics to be specified in the class schedule) Development of a selected branch of mathematics. Topics may vary each term.

**Upper Division****MATH 3030 Geometry for Teachers (3 units)**

Mathematical connections across the curriculum. Real numbers and geometry. Number patterns and geometric patterns. Geometry and algebra. Transformational geometry. Geometric probability and statistics. Recommended for students seeking a multiple subject teaching credential. Not applicable to the major or minor in mathematics. Satisfies G.E. area FI. Prerequisites: MATH 1030 and 1040 with a grade of C– or better, junior standing, or consent of instructor.

**MATH 3040 Insights from Mathematics (3 units)**

Mathematical connections across the disciplines. Mathematical topics selected from various disciplines such as art, music, philosophy, politics, and the natural sciences. Not applicable to the requirements for the majors or minor in mathematics. Designed specifically for future teachers. (LIBS Integrative: Scientific/ Mathematical Inquiry) Prerequisite: Completion of all lower division math and science requirements in the Liberal Studies major and upper division G.E. FI, with grades of C- or better.

**MATH 3060 Modern Geometry (3 units)**

Logic of proofs, Hilbert's Axiom System. Incidence, separation, congruence, and continuity. Geometry and real numbers. Neutral Geometry, Non-Euclidean Geometry. Transformations. Prerequisite: MATH 1420 with a grade of C– or better.

**MATH 3110 History of Mathematics (3 units)**

Origin and development of mathematical ideas from early civilization to the present time. Recommended for prospective and in-service teachers. Prerequisite: MATH 1420 with a grade of C– or better.

**MATH 3230 Differential Equations (3 units)**

Topics selected from linear systems, existence and uniqueness theorems, singular points, stability theory, transform analysis, and partial differential equations. Prerequisites: MATH 2460 and 2530 with grades of C– or better, or consent of instructor.

**MATH 3350 Applied Mathematical Models (3 units)**

Roles of mathematical models in society. Use of mathematical models to solve real world problems. Models in behavioral, life, management, and social sciences will be emphasized. Not applicable to the requirements for the majors or minor in mathematics. Satisfies G.E. area FI. Prerequisite: MATH 1040, 1500, 1600, 1610, or 1620 with a grade of C– or better.

**MATH 3400 Set Theory and Logic (3 units)**

(Formerly MATH 3420) Basic set theory and logic (especially as they apply to writing and understanding mathematical proofs), relations, functions, the Well-Ordering Theorem, and mathematical induction. Prerequisite: MATH 1420 with a grade of “C-” or better.

**MATH 3600 Theory of Numbers (3 units)**

(Formerly MATH 4500) Study of the properties of integers including mathematical induction, well ordering principle, Euclid's algorithm, divisibility properties, prime numbers, congruence of numbers, calculations, conjectures, selected advanced topics, and selected applications. Prerequisite: MATH 1420 with a grade of C– or better.

**MATH 4020 Mathematics for Secondary Teachers (3 units)**

Effective communication of mathematical ideas. Techniques for developing mathematical understanding and skills. Analysis and modeling of various forms of delivery of instruction. Prerequisites: MATH 2410 and MATH 2530, each with a grade of C– or better, senior standing, or consent of instructor.

**MATH 4022 Mathematics for Secondary Teachers Laboratory (1 unit)**

Construction of mathematics to be taught. Communication with mathematics students. Being a classroom facilitator and tutor at a local school for at least twenty hours. Prerequisite: MATH 2410 and MATH 2530, each with a grade of C– or better, senior standing, or consent of instructor.

**MATH 4130 Real Analysis I (3 units)**

The real number system, sequences, topology of the real line, limits, continuity, and differentiation. Prerequisites: MATH 2410, 2530, 3400, and six additional upper-division units in mathematics (other than MATH 3030, 3040, 3350, 4020, and 4022) with a grade of C– or better or consent of instructor.

**MATH 4140 Real Analysis II (3 units)**

Riemann integral, infinite series, uniform convergence, and metric spaces. Prerequisite: MATH 4130 with a grade of C– or better or consent of instructor.

**MATH 4330 Numerical Analysis (3 units)**

Topics selected from floating point arithmetic, errors, nonlinear equations, interpolation, numerical integration, linear systems, and numerical solution of differential equations. Prerequisites: MATH 2410, 2460, 2530, and CS 1500 with grades of C– or better or consent of instructor.

**MATH 4430 Operations Research (3 units)**

Linear programming theory and applications. Network analysis. Topics selected from game theory, dynamic programming, integer programming, queueing theory, inventory theory, project planning, and scheduling techniques. Prerequisite: MATH 2530 with a grade of C– or better or consent of instructor.

**MATH 4530 Abstract Algebra (3 units)**

An introduction to the development of the algebraic structures that arise in mathematics and their applications. Topics will be selected from groups, rings, integral domains, fields, and selected applications. Prerequisites: MATH 2410, 2530, 3400, and six additional upper-division units in mathematics and/or computer science with grades of C– or better (other than MATH 3030, 3040, 3350, 4020, 4022, or CS 4000) or consent of instructor.

**MATH 4600 Complex Variables (3 units)**

Complex numbers, analytic functions, Cauchy–Riemann equations, Cauchy's theorem, Laurent series, calculus of residues, and selected applications. Prerequisite: MATH 2410 with a grade of C– or better.

**MATH 4630 Probability Theory (3 units)**

Concepts of sample space, probability, random variable, expectation, moment, elementary combinatorial analysis; moment generating function, distribution, and density function. Emphasis on theory and applications. Prerequisites: MATH 1620 and 2410 with grades of C– or better or consent of instructor.

**MATH 4640 Statistical Inference (3 units)**

Review of relevant probability distributions. Estimation, hypothesis testing, regression, correlation, and analysis of enumerative data. Emphasis on theory and applications. Prerequisites: MATH 2530 and 4630 with grades of C– or better, or consent of instructor.

**MATH 4910 Cooperative Education (1-4 units)**

Provides an opportunity to acquire relevant, practical experience in supervised paid employment within the discipline. Students are placed in private or public sector positions under the supervision of the employer and departmental Co-op coordinator. May be repeated for a total of 6 units. At most two units of MATH 4910 and/or MATH 4940 are applicable to the requirements for the majors or minor in mathematics. Prerequisites: Sophomore standing; consent of department Cooperative Education coordinator.

**MATH 4940 Internship in Mathematics (1-4 units)**

Designed for students in mathematics who want to apply their educational experience as an intern to a practical situation in a public or private agency. At most two units of MATH 4910 and/or MATH 4940 are applicable to the requirements for the majors or minor in mathematics. Prerequisite: Consent of Department Internship Coordinator.

**MATH 4950 Selected Topics in Mathematics (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of mathematics. Topics vary each term. Different topics may be taken for credit. Prerequisites: Senior standing and consent of instructor.

**MATH 4960 Senior Seminar in Mathematics (WP) (3 units)**

Synthesizes mathematical knowledge and skills acquired in lower- and upper-division mathematics courses. Oral and written communication of mathematical ideas and problem solving will be emphasized. Satisfies upper-division writing proficiency requirement. Prerequisites: Completion of the Writing Proficiency Screen Test with a passing score; MATH 1620, 2410, 2530, each with a grade of C– or better, completion of General Education-Breadth Requirement A, Communication Skills, declared major in mathematics or enrollment in Mathematics Subject Matter Preparation Program, senior standing, and 15 upper-division units in mathematics applicable to a degree in mathematics or the Mathematics Subject Matter Preparation Program with a grade of C– or better.

**MATH 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisites: Senior standing and consent of instructor.

**Department of Physics,  
Physical Sciences, and Geology**

Ian M. Littlewood, Ph.D., *Chair*

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## Geology

Horacio Ferriz, Ph.D., *Program Coordinator*

**Professor:** Giaramita

**Associate Professor:** Ferriz

**Assistant Professors:** Rogers, Sankey

Office: Naraghi Hall of Science — N162  
Phone: (209) 667-3466

**Bachelor of Science in Geology  
with a concentration in Applied Geology  
Minor in Geology  
Liberal Studies degree concentration in Earth Sciences**

The Bachelor of Science degree in Geology is designed to provide the kind of comprehensive background required for students who wish to seek additional training in graduate and/or professional schools. A concentration in Applied Geology serves as professional preparation for employment as hydrologist, engineering geologist, and environmental geologist.

## Bachelor of Science in Geology

### Requirements

1. Complete University General Education requirements for a Bachelor of Science degree (51 units minimum).
2. Complete the following prerequisites to the major (24 units):
  - a. MATH 1070 College Algebra (3 units) and MATH 1080 Trigonometry (3 units) [or MATH 1100 Precalculus (4 units) or MATH 1410 Calculus I (4 units) in place of MATH 1070]
  - b. CHEM 1100 Principles of Chemistry I (5 units)
  - c. PHYS 2100 Basic Physics I (5 units)
  - d. GEOL 2100 Principles of Geology (3 units) and GEOL 2102 Principles of Geology Lab (1 unit)
  - e. GEOL 2200 History of Earth and Life (3 units) and GEOL 2202 History of Earth and Life Laboratory (1 unit)

3. Complete the major of not less than 51 upper-division units as specified for the Bachelor of Science degree. Some of these units can be counted toward completion of the Applied Geology concentration.
4. Completion of a minor or a concentration is not required.

### The Major (51 units)

1. Complete the following required courses (39 units):
  - GEOL 3250/3252 Mineralogy, 4 units
  - GEOL 3810 Hydrogeology, 4 units
  - GEOL 4100/4102 Igneous and Metamorphic Petrology, 4 units
  - GEOL 4350 Geophysical Exploration, 4 units
  - GEOL 4360/4362 Structural Geology, 4 units
  - GEOL 4380/4382 Sedimentary Rocks and Depositional Environments, 4 units
  - GEOL 4390 Paleontology and Stratigraphy, 4 units
  - GEOL 4400 Applied Geology, 3 units
  - GEOL 4402 Applied Geology Laboratory, 1 unit
  - GEOL 4500 Field Geology (WVP), 4 units
  - GEOL 4700 Plate Tectonics, 3 units
2. Select a minimum of 12 units from the following electives. No more than two courses from list b. can be used to satisfy this requirement. Substitution of courses is permitted by approval of adviser.
  - a.
    - GEOL 3050/3053 Environmental Geology, 4 units
    - GEOL 3600 Physical Oceanography, 3 units
    - GEOL 3800/3802 Optical Mineralogy, 3 units
    - GEOL 3900 Soil Geology: Application to Agriculture and Hydrogeology, 3 units
    - GEOL 4810/4813 Development and Management of Water Resources, 4 units
    - CHEM 1110 Principles of Chemistry II, 5 units
    - PHYS 2110 Basic Physics II, 5 units
    - MATH 1410 Calculus I, 4 units
    - MATH 1420 Calculus II, 4 units
  - b.
    - GEOL 2300 Numerical Analysis of Geologic Data, 3 units
    - GEOL 2500 Dinosaurs, 3 units
    - GEOL 3500 Earthquakes and Volcanoes, 3 units
    - GEOL 4000 Geologic Field Excursions, 2 units
    - GEOG 4750 Geographic Information Systems, 3 units
    - GEOG 4120 Geomorphology, 3 units
    - CHEM 3100 Environmental Chemistry, 3 units

**Applied Geology Concentration**

(10 units)

Students wishing to have the Applied Geology Concentration may do so by completing at least three of the following courses to satisfy the elective course requirements of the BS degree.

GEOL 3050 Environmental Geology, 4 units

GEOL 4810 Development and Management of Water Resources, 4 units

GEOG 4750 Geographic Information Systems, 3 units

CHEM 3100 Environmental Chemistry, 3 units

**Minor in Geology****Requirements** (18 units)

1. Complete the following lower-division courses:

GEOL 2100 Principles of Geology, 3 units

GEOL 2102 Principles of Geology Lab, 1 unit

GEOL 2200 History of Earth and Life, 3 units

GEOL 2202 History of Earth and Life Lab, 1 unit

*Note:* Equivalent substitution permitted with approval of minor adviser.

2. Complete upper-division Geology courses as approved by minor adviser, 10 units.

**Liberal Studies Concentration in Earth Sciences**

Please refer to the Liberal Studies section of the catalog.

**Teaching Credentials**

Students interested in a single subject teaching credential in the sciences must consult with their adviser about the subject matter competency requirements.

**Learning Objectives**

Geology majors will be able to:

- Demonstrate literacy in Earth's processes.
- Classify, identify and interpret geologic materials.
- Produce and interpret geologic maps and cross-sections.
- Collect and interpret quantitative scientific data related to earth processes.
- Apply fundamentals of chemistry, physics, math and computer science to solving geologic problems.
- Effectively communicate scientific ideas and results verbally and in writing.
- Retrieve, assimilate and evaluate factual data.
- Use, formulate and test multiple working hypotheses based on the scientific method.
- Use keen observational skills in the laboratory.
- Use keen observational skills in the field.
- Visualize subsurface structures and processes in 3 dimensions.
- Demonstrate depth and breadth of knowledge in one or more advanced specialty fields (advanced electives).

- Recognize, appreciate and communicate scientific uncertainty.
- Conduct independent field work.
- Understand geologic time, evolution, and global processes (e.g., plate tectonics).
- Propose workable solutions to societal problems related to resource exploration and development, construction with the Earth, and environmental issues related to Earth processes.
- Use up-to-date concepts when teaching Earth Science in the classroom.

**Course Descriptions****Lower Division****GEOL 2000 California Geology (3 units)**

(Formerly GEOL 2001 Regional Geology of California) Geology of California, with field studies of the Sierra Nevada, San Andreas fault, Coast Ranges, and Central Valley. Plate tectonics, geologic time, evolution and history of California, and its life. Satisfies G.E. area B1 (includes field trips) (Fall, Spring)

**GEOL 2100 Principles of Geology (3 units)**

An introductory course in physical geology dealing with materials and the internal and external processes of the Earth. Includes global plate tectonics processes responsible for producing and sculpturing geological features of the Earth's crust. Satisfies G.E. area B1. (Lecture, 3 hours) (CAN GEOL 2) (Fall, Spring)

**GEOL 2102 Principles of Geology Laboratory (1 unit)**

Laboratory to accompany GEOL 2000, 2100 or GEOL 2400. Classification of minerals and rocks; reading and interpreting topographic and geologic maps; studies of selected problems in plate tectonic, structural geology, groundwater and mass movement. One required field trip. Satisfies G.E. area B1. Pre- or corequisite: GEOL 2000, 2100, or 2400. [Required for Geology majors and those seeking a teaching credential under the science waiver program; otherwise optional.] (Laboratory, 3 hours, including a field trip.) (Fall, Spring)

**GEOL 2200 History of Earth and Life (3 units)**

(Formerly Historical Geology) The evolution and history of Earth and life. Emphasis on past geographic, climatic, and evolutionary changes and causes of past mass extinctions. Comparisons to today's climate change and extinctions. One required field trip. Students with a major or minor in Geology or those seeking a teaching credential in the sciences must take the accompanying lab concurrently (GEOL 2202). Satisfies G.E. area B1. (Lecture, 3 hours, including required field trips) (CAN GEOL 4) (Spring)

**GEOL 2202 History of Earth and Life Laboratory (1 unit)**

Optional laboratory to accompany GEOL 2200 (History of Earth and Life). Topics of lab exercises will include common minerals and rocks, especially sedimentary rocks and depositional environments, relative time, rock and fossil stratigraphy, radiometric dating techniques, stratigraphic sequences, geologic maps and cross sections, fossils, paleoecology, and evolution. Lab is required for Geology majors and minors and those seeking a teaching credential under the Science Subject Matter Preparation Program; otherwise optional. Satisfies G.E. area B1. Concurrent enrollment: GEOL 2200. (CAN GEOL 4) (Spring)

**GEOL 2300 Numerical Analysis of Geologic Data (3 units)**

Course covers the various mathematical techniques commonly used by Earth scientists. Includes equation manipulation, trigonometry, logarithms and exponential functions, statistics, matrix algebra, numerical methods for differentiation and integration, and Excel-based computer literacy. Prerequisite: MATH 1100 or consent of instructor. (Fall of odd-numbered years)

**GEOL 2400 Introduction to Earth Science (3 units)**

Examination of the Earth, its place in the solar system and universe, and its surface, interior, hydrosphere, and atmosphere. Relationships among these earth systems, major earth processes, natural resources, and natural disasters are examined. Satisfies G.E. area B1. (Lecture, 3 hours, including required field trips)

**GEOL 2500 Dinosaurs (3 units)**

Examines evolutionary history and extinction of dinosaurs; past climatic, environmental, and geographic changes; current topics in dinosaur paleobiology such as feathered dinosaurs, mass extinctions, polar dinosaurs, and new discoveries. Satisfies G.E. area B1. (Fall)

**Upper Division****GEOL 3050 Environmental Geology (4 units)**

(Formerly GEOL 3000) Explores environmental remediation, mineral and energy resources, solid waste disposal, and protection of water resources. Includes three field trips and one Forum Day. ITV presentation. Satisfies G.E. area F1. Corequisite: GEOL 3053. (Lecture, 3 hours; activity, 2 hours) Prerequisites: None; recommend GEOL 2100. (Spring of odd years)

**GEOL 3250 Mineralogy (4 units)**

(Formerly GEOL 4300) Course concerning minerals. Examines crystallography; crystal chemistry; genesis; physical properties; behavior in igneous, metamorphic, and sedimentary environments; minerals in ore deposits; optical properties; and identification both in hand specimen and with optical microscope. Corequisite: GEOL 3252. Prerequisites: GEOL 2100 and GEOL 2102. CHEM 1100 to be taken concurrently if not taken previously, or consent of instructor. (Lecture, 3 hours; laboratory, 3 hours)

**GEOL 3500 Earthquakes and Volcanoes (3 units)**

Application of the scientific method and geologic principles to study the nature, causes and consequences of earthquakes and volcanoes. Satisfies G.E. area F1. Prerequisite: Completion of lower-division General Education in natural sciences and mathematics, or consent of instructor. (Lecture, 3 hours) (Fall, Spring)

**GEOL 3600 Physical Oceanography (3 units)**

Course examines the oceans from a geologic perspective and integrates aspects of physics, chemistry, and biology. Upper-division elective in Geology, elective for Science Subject Matter Preparation Program, required for Geology Subject Matter Preparation Program. No prerequisites; GEOL 2100 is recommended. ITV presentation. Satisfies G.E. area F1. (Lecture, 3 hours) (Spring of odd-numbered years)

**GEOL 3650 Geohazards: The Geological Science of Natural Disasters (3 units)**

Examines the scientific method and applies it to the study of natural disasters, including earthquakes, volcanic eruptions, soil erosion and pollution, stream pollution and flooding, landslides, solid waste disposal, atmospheric geohazards, and severe weather geohazards. Designed specifically for future teachers. (LIBS Integrative: Scientific/Mathematical Inquiry) Corequisite: GEOL 3652. Prerequisite: Completion of all G.E. or Liberal Studies requirements in area B. (Lecture, 2 hours; laboratory, 3 hours)

**GEOL 3800 Optical Mineralogy (3 units)**

Optical properties of minerals; identification of selected minerals by optical methods; theory and use of polarizing microscope for determining optical properties of minerals. Corequisite: GEOL 3802. Prerequisites: GEOL 2100 and GEOL 2102. (Lecture, 2 hours; laboratory, 3 hours)

**GEOL 3810 Hydrogeology (4 units)**

Course addresses the movement of water through the ground, the relationship between geology and groundwater flow, the chemistry of groundwater, and the development of groundwater as a resource. Corequisite: GEOL 3812. Prerequisites or corequisites: GEOL 2100 and 2200, or consent of instructor. (Lecture, 3 hours; laboratory or field trips, 3 hours) (Spring of odd-numbered years)

**GEOL 3900 Soil Geology: Application to Agriculture and Hydrogeology (3 units)**

A study of the linkages between geology, hydrogeology, and soil sciences; emphasis on soil genesis, including weathering and alteration of organic compounds, soil texture, soil structure, soil profile, soil classification, soil testing, and soil conservation. Prerequisites: GEOL 2100 and GEOL 2102 or consent of instructor. (Lecture, 3 hours)

**GEOL 4000 Geologic Field Excursions (2 units)**

(Formerly California Field Excursions) Provides students with directed field experiences, involving long weekends or winter semester travel to study geologically significant areas in California, the United States, or abroad. Course may be repeated to different destinations. Corequisite: GEOL 4003. Prerequisite: Recommended but not required GEOL 2000, GEOL 2100, or GEOL 2200. (Lecture, 1 hour; activity, 2 hours)

**GEOL 4100 Igneous and Metamorphic Petrology (4 units)**

(Formerly GEOL 3700) The origin, description, and interpretation of igneous and metamorphic rocks. Lecture focuses on concepts, processes, theory, and research concerning the genesis of igneous and metamorphic rocks; laboratory focus is on identification, classification, and interpretation. Course entails use of optical microscope to study rocks. Field trips. Corequisite: GEOL 4102. Prerequisites: GEOL 2100 and GEOL 2102; GEOL 3250. (Lecture, 3 hours; laboratory, 3 hours)

**GEOL 4350 Geophysical Exploration (4 units)**

Geophysical exploration techniques: seismic wave propagation; seismic recording instruments; seismic reflection and refraction methods; gravity surveys; magnetic surveys; and geological interpretation of geophysical data. Pre or corequisites: PHYS 2110, MATH 1070, and MATH 1080, or consent of instructor. (Lecture, 4 hours) (Fall of odd-numbered years)

**GEOL 4360 Structural Geology (4 units)**

Structural geology deals with the ways that rocks respond to deforming forces. The ultimate aim of structural geology is to establish the history of displacements, strains, stresses, strain rates, temperatures, and pressures that the crust and upper mantle have experienced. Corequisite: GEOL 4362. Prerequisites: GEOL 2100 and GEOL 2102. (Lecture, 3 hours; laboratory, 3 hours) (Fall, alternate years)

**GEOL 4380 Sedimentary Rocks and Depositional Environments (4 units)**

(Formerly Sedimentary Rocks) Modern depositional environments are investigated to interpret sedimentary rock deposits (facies model approach). Labs on sedimentary rock identification, description, and analysis. Field exercises on modern and ancient depositional environments. Field trips are required. Corequisite: GEOL 4382. Prerequisites: GEOL 2100, 2102, 2200, and 2202. (Lecture, 3 hours; laboratory, 3 hours) (Fall of even-numbered years)

**GEOL 4390 Paleontology and Stratigraphy (4 units)**

(Formerly Stratigraphy) Paleontology, the study of fossils, includes fossil preservation, identification, paleoecology, and evolution. Stratigraphy, the distribution of sedimentary rocks in time and space, includes stratigraphy based on rocks, fossils, chemical, and geophysical properties. Lab and field exercises. Corequisite: GEOL 4392. Prerequisites: GEOL 4380 and GEOL 4382. (Lecture, 3 hours; laboratory, 3 hours, including required field trips)

**GEOL 4400 Applied Geology (3 units)**

A practical course about the nature of professional geologic work. Includes discussions about engineering geology (the application of geology to the solution of engineering problems, including civil and sanitary engineering), soil mechanics, rock mechanics, hydrogeology, resource exploration (minerals and petroleum), and environmental geology. Pre- or corequisites: GEOL 3250, GEOL 4350, and GEOL 4390, or consent of instructor. (Spring, even-numbered years)

**GEOL 4402 Applied Geology Laboratory (1 unit)**

Laboratory to accompany GEOL 4400. Soil mechanics, rock mechanics, slope stability analysis, rockfall analysis, seismic engineering, coastal erosion, waste management, exploration for mineral resources, environmental geology. Corequisite: GEOL 4400. (Laboratory, 3 hours, including some field trips) (Spring, even-numbered years)

**GEOL 4500 Field Geology (WP) (4 units)**

Field methods; use of geological maps in field study; locate and study specific geologic structures; preparation of local maps and formal geologic reports. Satisfies upper-division writing proficiency requirement. Corequisite: GEOL 4502. Prerequisites: Completion of the Writing Proficiency Screening Test with a passing score; GEOL 2100 and GEOL 2102 or consent of instructor. (Lecture, 2 hours; laboratory or field work, 6 hours) (Spring, alternate years)

**GEOL 4700 Plate Tectonics (3 units)**

(Formerly GEOL 3400) Study of plate tectonic theory — the unifying theory in geology. Continental drift, sea-floor spreading, paleomagnetism, seismic evidence, petrology, geochemistry, structural geology, paleontology, and ore geology, both in support of and implied by the theory, are examined. Prerequisites or corequisites: GEOL 3250, GEOL 4100, and GEOL 4380. (Spring of odd-numbered years)

**GEOL 4810 Development and Management of Water Resources (4 units)**

(Formerly Water Resources Development and Management) Addresses the growing challenges related to water supply, sustainable solutions to these challenges, strategies for development of water resources, watershed management, and drought management. ITV lectures, three field visits, and one Forum Day. Satisfies G.E. area F1. Corequisite: GEOL 4813. (Lecture, 3 hours; activity, 2 hours) (Fall of even-numbered years)

**GEOL 4940 Geology Internship (1-3 units)**

Intended for students who are serving as interns or conducting fieldwork with private or governmental agencies. May be repeated for a total of 6 units. Prerequisites: Upper-division standing and consent of adviser. (Fall, Spring)

**GEOL 4950 Selected Topics in Geology (1-5 units)**

(Topics to be specified in the Schedule of Classes.) Special studies in selected areas of geology. Course content may vary each term; different titles may be taken for credit. Prerequisite: Upper-division standing or consent of instructor. (Fall, Spring)

**GEOL 4980 Individual Study (1-4 units)**

For the student capable of independent study in geology; may be field-oriented or the study of some specialized topic. Prerequisite: Consent of instructor. (Fall, Spring)



## Physics and Physical Sciences

**Professors:** Chow, Johnson, M., Littlewood, Zhang

**Assistant Professor:** Mokhtari

### Bachelor of Arts and Bachelor of Science in Physics

#### Bachelor of Arts in Physical Sciences

with concentrations in Applied Physics,  
Earth and Space Sciences, or Environmental Sciences

#### Minor in Microelectronics

#### Minor in Physics

#### Minor in Physical Sciences

#### Liberal Studies degree concentration in Physics and Physical Sciences

## Bachelor of Arts and Bachelor of Science in Physics

The Physics curriculum gives students a thorough understanding of the fundamentals and modern applications of physics. The Bachelor of Science program prepares the student for graduate school, a career in scientific research and development, or industrial work. It is also intended for students preparing for interdisciplinary studies on the graduate level in fields such as astronomy and astrophysics, atmospheric science, biophysics, engineering, environmental science, geophysics, or physical oceanography.

The Bachelor of Arts degree program is designed for students seeking to enter professions requiring a moderate training in physics. The lower-division requirements of both degree programs also may be used to prepare for study in engineering. After completion, the student may transfer to engineering programs for upper-division coursework and study in engineering.

### Requirements

1. Complete University General Education requirements for the Bachelor of Arts or Bachelor of Science degree (51 units minimum).
  2. Complete the following prerequisites to the major (32-35 units):
    - a. Required courses in major field (10 units):
      - PHYS 2250, 2260 General Physics I, II, 8 units
      - PHYS 2252, 2262 General Physics Laboratory I, II, 2 units
    - b. Required courses in supporting fields (22-25 units):
      - CHEM 1100, 1110 Principles of Chemistry I, II, 10 units
      - MATH 1410, 1420 Calculus I, II, 8 units
      - MATH 2410 Multivariate Calculus, 4 units
- Bachelor of Arts students complete additionally:
- CS 1500 Computer Programming I, 3 units

3. Complete the major of not less than 25 upper-division units as specified for the Bachelor of Arts degree, or 35 upper-division units as specified for the Bachelor of Science degree. No courses graded CR may be counted towards the major except for eight units graded exclusively CR/NC.
4. Completion of a minor is not required.

### The Bachelor of Arts Major (25 units)

1. Complete the following courses (22 units):
  - PHYS 3010 Introduction to Mathematical Physics I, 3 units
  - PHYS 3100 Classical Mechanics, 4 units
  - PHYS 3320, 3330 Electricity and Magnetism I, II, 6 units
  - PHYS 3520 Modern Physics and Quantum Mechanics, 3 units
  - PHYS 4102 Advanced Physics Laboratory, 2 units
  - PHYS 4250 Analog and Digital Electronics, 4 units
2. Complete at least three credit hours from the following courses:
  - PHYS 4450 Nuclear and Particle Physics, 3 units
  - PHYS 4560 Solid State Physics, 3 units
  - PHYS 4900 Modern Optics and Lasers, 3 units

### The Bachelor of Science Major (35 units)

1. Complete the following courses (32 units):
    - PHYS 3010 Introduction to Mathematical Physics I, 3 units
    - PHYS 3100 Classical Mechanics, 4 units
    - PHYS 3320, 3330 Electricity and Magnetism I, II, 6 units
    - PHYS 3520 Modern Physics and Quantum Mechanics, 3 units
    - PHYS 4102 Advanced Physics Laboratory, 2 units
    - PHYS 4250 Analog and Digital Electronics, 4 units
    - PHYS 4510 Quantum Mechanics I, 3 units
    - PHYS 4520 Quantum Mechanics II, 3 units
    - PHYS 4530 Thermal and Statistical Physics, 4 units
  2. Select three units of upper-division electives in physics and physical sciences.
- Note: The department recommends the following electives:*
- PHYS 3020 Introduction to Mathematical Physics II, 3 units
  - PHYS 4450 Nuclear and Particle Physics, 3 units
  - PHYS 4560 Solid State Physics, 3 units
  - PHYS 4900 Modern Optics and Lasers, 3 units
  - ASTR 3000 Contemporary Astronomy, 3 units

## Minor in Physics

### Requirements (18 units)

Complete 18 units in Physics as approved by the minor adviser, to include at least 8 upper-division units.

### Minor in Microelectronics

This degree minor provides a theoretical and practical understanding of analog/digital signal processing techniques and microprocessor interfacing techniques, with an emphasis on the design and implementation of instrumentation for scientific experiments.

#### Requirements (25 units)

- Complete the following lower-division courses (14 units):
  - CS 1500 Computer Programming I, 3 units
  - CS 2500 Computer Programming II, 3 units
  - CS 2700 Assembly Language and Computer Architecture, 3 units
  - PHYS 2260 General Physics II, 4 units
  - PHYS 2262 General Physics Laboratory II, 1 unit
- Complete the following upper-division courses (11 units):
  - CS 3740 Computer Organization, 3 units
  - PHYS 4250 Analog and Digital Electronics, 4 units
  - PHYS 4300 Microprocessor Electronics, 3 units
  - PHYS 4302 Microprocessor Laboratory, 1 unit

#### Liberal Studies Concentration in Physics

Please refer to the Liberal Studies section of the catalog.

### Bachelor of Arts in Physical Sciences

This interdisciplinary degree prepares students for a greater diversity of professions requiring an understanding of the fundamentals of the physical sciences, including courses in: astronomy, chemistry, environmental sciences, geology, marine sciences, meteorology, and physics.

A student may pursue a Physical Sciences major by electing one of the following three concentrations: applied physics, earth and space sciences, or environmental sciences. The major may also be pursued without a concentration by completing sufficient upper-division units in two areas of interest chosen from astronomy, chemistry, environmental sciences, geology, marine science, and physics. Consult with a departmental adviser as to the areas of interest and to the proper selection of courses.

Students interested in environmental design, technical administration in government and industry, laboratory technology, legal work pertaining to patents, or scientific librarianship and journalism may elect this major as an opportunity to acquire an education tailored to their individual needs.

The Physical Sciences major whose interest is in marine geology and physical oceanography will be required to enroll in upper-division coursework at the Moss Landing Marine Laboratories for fulfillment of major requirements. Please refer to the Marine Sciences section of the Graduate Catalog.

Physical Sciences majors interested in medical school, dental school, and other health professions such as pharmacy, physical therapy, or optometry should work out a plan of study as soon as possible with their major adviser and the Pre-Health Professions Committee. See the Pre-Health Professions section of this catalog within the Biological Sciences section.

#### Requirements

- Complete University General Education requirements for the Bachelor of Arts degree (51 units minimum).
- Complete the following prerequisites to the major (28 units):
  - PHYS 2250, 2260 General Physics I, II, 8 units, **and** PHYS 2252, 2262 General Physics Lab I, II, 2 units, **or** PHYS 2100, 2110 Basic Physics I, II, 10 units
  - CHEM 1100, 1110 Principles of Chemistry I, II, 10 units
  - MATH 1410, 1420 Calculus I, II, 8 units
- Complete the major of not less than 24 upper-division units of physical sciences.
- No courses graded CR may be counted toward the major except for 8 units taken in courses graded exclusively CR/NC.
- No minor is required.

#### The Major

Complete upper-division courses of not less than 24 units by satisfying either 1 or 2 below:

- The student who pursues a Physical Sciences major without a concentration must select two areas of interest in Physical Sciences and complete upper-division courses of not less than 12 units from these areas. The student may, in consultation with the adviser, complete any other courses in Physical Sciences or Mathematics to meet the total required for the major of 24 upper-division units.
- The student also may pursue a Physical Sciences major by completing one of the following concentrations and other appropriate upper-division courses to satisfy the total required units for the major of 24 upper-division units

### Applied Physics Concentration

#### Requirements (25 units)

- Complete the following courses (13 units):
  - PHYS 3520 Modern Physics and Quantum Mechanics, 3 units
  - PHYS 4102 Advanced Physics Lab, 2 units
  - PHYS 4250 Analog and Digital Electronics, 4 units
  - PHYS 4930 Lasers and Holography, 4 units
- Select 12 upper-division units in Physical Sciences or Mathematics, in consultation with the adviser.

### Earth and Space Sciences Concentration

#### Requirements (24 units)

- Select 12 units from the following:  
 ASTR 3000 Contemporary Astronomy, 3 units  
 GEOL 3050 Environmental Geology, 4 units  
 GEOL 3250 Mineralogy, 4 units  
 GEOL 4700 Plate Tectonics, 3 units
- Select 12 upper-division units in physical sciences or mathematics, in consultation with the adviser.  
 One elective course may be chosen from the following:  
 GEOG 3100 Climatology, 3 units  
 GEOG 3700 Cartography, 3 units  
 GEOG 4120 Geomorphology, 3 units

### Environmental Sciences Concentration

#### Requirements (24 units)

- Complete the upper-division requirements of the Environmental Sciences concentration, 13 units. (See the Environmental Sciences section of this chapter.)
- Select an additional 11 upper-division units of courses in consultation with the adviser.

### Minor in Physical Sciences

#### Requirements (18 units)

Complete 18 units in physical sciences as approved by the minor adviser, to include at least 8 units in upper-division.

#### Liberal Studies Concentration in Physical Sciences

Please refer to the Liberal Studies section of the catalog.

#### Learning Objectives

Physics majors will:

- Acquire a basic understanding of the core areas in physics, including classical mechanics, electricity and magnetism, quantum mechanics, and thermodynamics.
- Be able to solve physical problems in a wide range of contexts of physics.
- Have an understanding of scientific method and how to apply it.
- Develop analytical skills and apply them to solve problems in physics.
- Apply mathematical skills and reasoning to solve problems and to derive quantitative results on which their conclusions are based.
- Develop basic laboratory skills and become familiar with measurements and data analysis techniques used in physics and other physical sciences.

- Demonstrate the ability to evaluate the quality and usefulness of their data in reaching a conclusion.
- Use scientific software to present and analyze their data scientifically.
- Learn to participate and contribute effectively as a team member in an experiment.
- Demonstrate the ability to communicate scientific information orally and in writing.
- Demonstrate the ability to search and find information in the physics literature.
- Demonstrate the ability to critically evaluate scientific communications (written or oral).
- Learn to participate and contribute effectively in a team discussion on physics.

### Course Descriptions

#### Physics: Lower Division

##### PHYS 1500 Energy and Matter (3 units)

Survey of the basic concepts and principles of physics. Topics will range from classical Newtonian mechanics to modern theories of the atom and the nucleus. Satisfies G.E. area B1. Prerequisite: MATH 0106 or MATH 0110, or a passing score on the ELM test or equivalent. (Lecture, 3 hours) (Fall, Spring)

##### PHYS 1502 Energy and Matter Laboratory (1 unit)

Optional laboratory to accompany PHYS 1500. Satisfies G.E. area B1. Prerequisite: PHYS 1500 or concurrent enrollment in PHYS 1500. (Fall, Spring)

##### PHYS 2100 Basic Physics I (5 units)

(Formerly PHYS 1100) General physics without using calculus, Newtonian mechanics, wave motion, heat, and thermodynamics. Designed for general students and for students preparing for biology or medicine. Satisfies G.E. area B1. Corequisites: PHYS 2102 and 2104. Prerequisites: Algebra and trigonometry, or consent of instructor. (Lecture, 3 hours; discussion, 1 hour; laboratory, 3 hours) (CAN PHYS 2) (Fall, Spring)

##### PHYS 2110 Basic Physics II (5 units)

(Formerly PHYS 1110) Continuation of PHYS 2100. Electricity and magnetism, light, optics, atoms, and nuclei. Satisfies G.E. area B1. Corequisites: PHYS 2112 and PHYS 2114. Prerequisite: PHYS 2100. (Lecture, 3 hours; discussion, 1 hour; laboratory, 3 hours) (CAN PHYS 4) (Fall, Spring)

##### PHYS 2250 General Physics I (4 units)

Calculus-based general physics course for science and mathematics majors. It covers basic mechanics, including motion in a plane, conservation of energy and momentum, rotational motion and angular momentum, harmonic motion and gravitation. Satisfies G.E. area B1. Corequisite: PHYS 2254. Prerequisite: MATH 1410 or consent of instructor. (CAN PHYS 8) (Fall)

**PHYS 2252 General Physics Laboratory I (1 unit)**

(Formerly PHYS 2350) Laboratory to accompany PHYS 2250. Satisfies G.E. area B1. Prerequisite: PHYS 2250 or concurrent enrollment in PHYS 2250. (Fall)

**PHYS 2260 General Physics II (4 units)**

Continuation of PHYS 2250. Covers electricity and magnetism, including electrostatics, basic circuits, magnetostatics, Faraday's Law and Induction, and electromagnetic oscillations. Corequisite: PHYS 2264. Prerequisites: PHYS 2250 and MATH 1420 or concurrent enrollment in MATH 1420. (Lecture, 3 hours; discussion, 1 hour) (CAN PHYS 12) (Spring)

**PHYS 2262 General Physics Laboratory II (1 unit)**

(Formerly PHYS 2360) Laboratory to accompany PHYS 2260. Prerequisite: PHYS 2260 or concurrent enrollment in PHYS 2260. (Spring)

**PHYS 2270 General Physics III (3 units)**

Continuation of PHYS 2260, covering thermodynamics, waves, optics, and introductory quantum mechanics. Prerequisites: PHYS 2250 and MATH 1420. (Lecture, 3 hours) (CAN PHYS 14)

**PHYS 2272 General Physics Laboratory III (1 unit)**

(Formerly PHYS 2370) Continuation of PHYS 2262, covering thermodynamics, waves and optics, and modern physics. Prerequisites: PHYS 2260 and MATH 1420.

**Physics: Upper Division****PHYS 3010 Introduction to Mathematical Physics I (3 units)**

Matrix algebra, tensors, formulations of the partial differential equations of classical and quantum physics, and the mathematical methods required for their solutions; integral transformations, theory of residues and conformal mapping, special functions. Examples are given from all fields of physics. Prerequisite: PHYS 2260. (Lecture, 3 hours)

**PHYS 3020 Introduction to Mathematics Physics II (3 units)**

Continuation of PHYS 3010. Prerequisite: PHYS 3010. (Lecture, 3 hours)

**PHYS 3080 How Things Work (3 units)**

An introduction to physics and the ways in which different aspects of the subject are combined in designing many of the machines and appliances which are in common everyday usage. Satisfies G.E. area F1. (Lecture, 3 hours)

**PHYS 3100 Classical Mechanics (4 units)**

Dynamics of particles and rigid bodies, gravitation. Lagrangian and Hamiltonian dynamics, theory of oscillations, and the wave equation. Prerequisite: PHYS 2260. (Lecture, 4 hours)

**PHYS 3200 Heat, Light, and Sound (3 units)**

An examination of several forms of energy and how we experience them in our everyday lives. It includes discussions of heat, light, and sound. Designed specifically for future teachers. (LIBS Integrative: Scientific/Mathematical Inquiry) Corequisite: PHYS 3203. Prerequisite: Completion of all G.E. requirements in areas B1 and F1, all with a grade C- or higher. (Lecture, 2 hours; activity, 2 hours)

**PHYS 3320 Electricity and Magnetism I (3 units)**

Electrostatics, magnetostatics, electric current, electromagnetic induction, Maxwell's equations, electromagnetic waves, radiative reaction, electric and magnetic properties of materials, properties of wave guides. Prerequisite: PHYS 2260. (Lecture, 3 hours)

**PHYS 3330 Electricity and Magnetism II (3 units)**

Continuation of PHYS 3320. Prerequisite: PHYS 3320. (Lecture, 3 hours)

**PHYS 3520 Modern Physics and Quantum Mechanics (3 units)**

Special relativity, origin of quantum theory, the nuclear atom and Bohr theory, elements of quantum mechanics and applications, atomic and nuclear physics, some properties of solids, and elementary particles. Satisfies G.E. area F1. Prerequisite: PHYS 2260 or consent of instructor. (Lecture, 3 hours)

**PHYS 3550 Physics for War, Physics for Peace (3 units)**

Discusses the scientific background behind some of the technologies which have found applications in both the civilian and military spheres. Satisfies G.E. area F1. One of two paired courses in the G.E. Summit Program (War and Peace). Prerequisites: Completion of lower-division area C2 requirements and consent of Summit Program Coordinator. (Lecture, 3 hours)

**PHYS 4102 Advanced Physics Laboratory (1 unit)**

Project type experiments in mechanics, heat, electricity, and magnetism, optics, atomic physics, nuclear physics, etc. Prerequisite: PHYS 3520 or consent of instructor. May be repeated for a maximum of 6 units. (Laboratory, 3 hours)

**PHYS 4250 Analog and Digital Electronics (4 units)**

(Formerly PHYS 4210 and PHYS 4220) An introduction to analog and digital electronics. Topics will be chosen from the following: AC and DC circuit analysis, diodes, transistors and operational amplifiers, feedback, active filters, transducers, Boolean logic, basic gates, sequential logic, flip-flops, counters, and an introduction to microprocessors. Corequisite: PHYS 4252. Prerequisite: PHYS 2260. (Lecture, 3 hours; laboratory, 3 hours)

**PHYS 4450 Nuclear and Particle Physics (3 units)**

Elements of nuclear structure; nuclear transformation; nuclear models; electromagnetic, weak, and strong interactions; properties of Leptons and Hadrons; symmetries and conservation laws; resonance particles, quarks and subhadronic particles; tools of nuclear and particle physics research. Prerequisite: PHYS 2260 or consent of instructor. (Lecture, 3 hours)

**PHYS 4510 Quantum Mechanics I (3 units)**

Development of Schrodinger's equation and its interpretations. Mathematical techniques for solution of problems in one and three dimensions. Perturbation and scattering theory. Solution of the hydrogen atom problem. Application to atomic phenomena. Prerequisite: PHYS 3520 or consent of instructor.

**PHYS 4520 Quantum Mechanics II (3 units)**

Continuation of PHYS 4510. Prerequisite: PHYS 4510. (Lecture, 3 hours)

**PHYS 4530 Thermal and Statistical Physics (4 units)**

Thermodynamics and statistical mechanics. A unified approach following Gibbs, based on a microscopic description using quantum states. Fermi, Bose, and "Classical" systems are discussed with applications to standard and current topics. Prerequisite: PHYS 3520 or consent of instructor. (Lecture, 4 hours)

**PHYS 4560 Solid State Physics (3 units)**

Crystal structure, metal crystals, molecular crystals. Thermal, electrical, magnetic properties of crystals. Free electron model of metals, band theory of solids. Prerequisite: PHYS 3520 or consent of instructor. (Lecture, 3 hours)

**PHYS 4900 Modern Optics and Lasers (3 units)**

Principles of geometrical optics, reflection, refraction, polarization, coherence and interference, Kirchhoff's diffraction theory, Fourier methods in optics, optics of solids, lasers and holography. Prerequisite: PHYS 2260 or consent of instructor. (Lecture, 3 hours)

**PHYS 4950 Selected Topics in Physics (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of physics. Topics may vary each term. Different topics may be taken for credit. Prerequisite: Upper-division standing or consent of instructor.

**PHYS 4980 Individual Study (1-4 units)**

For students capable of independent work and in need of advanced and specialized study. May be repeated for a total of 6 units. Prerequisites: Upper-division standing and consent of instructor.

**PHYS 4990 Undergraduate Thesis (1-2 units)**

Undergraduate thesis research. May be repeated for a total of 3 units. Prerequisites: Senior status with a major in physics, and GPA of 3.25 in all Physics major courses completed at CSU Stanislaus.

**Physical Sciences: Lower Division****PHSC 1300 Environmental Pollution (3 units)**

Survey of the pollution of the air, water, and land environment. The physical and chemical aspects of pollution by chemicals, pesticides, wastes, radioactivity, heat, and noise. Nuclear energy and radioactive pollution, solar energy, and other alternative energies and their environmental effects. Satisfies G.E. area B1. (Lecture, 3 hours)

**PHSC 2100 Atmosphere, Weather, and Climate (3 units)**

An introduction to weather and climate phenomena, with emphasis on the weather events that occur in California. Basic principles concerning behavior of the atmosphere and the physical processes underlying weather phenomena. Topics include cloud forms, precipitation, pollution, storms, weather maps, and elementary weather forecasting. Satisfies G.E. area B1. (Lecture, 3 hours)

**Physical Sciences: Upper Division****PHSC 4950 Selected Topics in Physical Sciences (1-5 units)**

(Topics to be specified in Class Schedule) Development of a selected branch of physical science. Topics may vary each term. Different topics may be taken for credit. Prerequisite: Consent of instructor.

**PHSC 4980 Individual Study (1-4 units)**

For students capable of independent work in need of advanced and specialized study. The Physical Sciences department encourages students to submit proposals in areas of their interest. Proposals should outline their projects and exhibit concrete plans for their successful completion. May be repeated for a total of 6 units. Prerequisites: Upper-division standing and consent of instructor.

**Astronomy: Lower Division****ASTR 2100 Descriptive Astronomy (3 units)**

Development of astronomical thought from Ptolemy to Einstein; the Earth and the moon; atoms; light and the tools of astronomers; planets, comets, and meteors; the sun, stars, stellar evolution; galaxies and cosmology. Satisfies G.E. area B1. (Lecture, 3 hours) (Fall, Spring)

**ASTR 2112 Astronomy Laboratory (1 unit)**

Telescope observations of the moon, planets, their satellites, and sunspots. Laboratory experiments related to astronomy. Satisfies G.E. area B1. Prerequisite: ASTR 2100 or concurrent enrollment in ASTR 2100.

**Astronomy: Upper Division**

**ASTR 3000 Contemporary Astronomy (3 units)**

A survey of recent developments in astronomy; gamma ray, x-ray, ultraviolet, infrared, and gravitational astronomy; stars, interstellar molecules, stellar evolutions, neutron stars, pulsars, and black holes; galaxies, radio galaxies, quasars; new trends in cosmological thinking, new findings of space programs about the planets and the sun. Satisfies G.E. area FI. Prerequisite: Upper-division standing or consent of instructor. (Lecture, 3 hours)

**Joint Engineering Program**

Marvin Johnson, Ph.D., *Program Director*

Office: Naraghi Hall of Science — N164  
Phone: (209) 667-3466

CSU Stanislaus and the University of the Pacific (UOP) are offering a unique joint program for students seeking a career in engineering. Students may earn a bachelor's degree at CSU Stanislaus in Computer Science, Mathematics, Physics, or another major in the sciences and continue taking courses at UOP to earn a bachelor's degree in Engineering. Through this program, preparation and opportunities can be enhanced for a career in engineering by also obtaining a degree in Computer Science, Mathematics, Physics, or another science. Industry is interested in hiring graduates who are articulate, versatile, and well-rounded—assets that will increase substantially with a second degree.

Employers know that, when combined with the engineering degree, a second degree in math or science leads to increased depth and technical strength. And this program is a great opportunity for students to earn as they learn. A Cooperative Education component offers full-time paid practical experience under the supervision of an engineer with a degree.

To participate in this program, students enroll at CSU Stanislaus and complete all General Education requirements, the prerequisites to both majors, and the CSU Stanislaus major. Then they can transfer easily to UOP to complete one of several Engineering majors with three years of additional full-time study.

After completing one year at UOP, with proper planning, students will be eligible to receive a CSU Stanislaus bachelor's degree. Through a joint agreement between CSU Stanislaus and UOP, an approved Transfer Program Agreement provides a guaranteed admission to UOP's Engineering major.

Students will be required to complete a minimum of 30 specified units at CSU Stanislaus and achieve an overall grade point average of 2.00 and a 2.75 in courses indicated on the Transfer Program Agreement. By carefully planning a full-time program of study, two bachelor's degrees can be received in no more than six years. This timeframe includes an opportunity to enroll in a Cooperative Education program, thereby earning an income, and obtaining valuable practical experience and knowledge of the industry.