COLLEGE OF SCIENCE

Simon J. Bernau, *Dean*
Victor P. Abegg, *Associate Dean*

The curricula offered in the College of Science combine fundamental education in science or mathematics with a broad human outlook, which develops the student's mental horizon beyond the limits of his/her immediate vocational objective.

Each curriculum is designed to prepare graduates for specific professional positions in industry, government and teaching or for graduate and professional work in their disciplines. The four-year sequence covers the basic major courses and has sufficient free electives to allow the students to develop specializations within the major and closely related fields.

General education courses are offered for all students. The need to understand the concepts of modern science and mathematics and their relationship to life in our present world is important. The College of Science also offers basic supporting courses for students enrolled in the professional and technological degree programs in other colleges of the university.

Majors in nine fields leading to the bachelor of science degree are offered by the College of Science. Information concerning the master's curricula may be found in the graduate listings.

The standard teaching credential program is offered for both the elementary specialization and the secondary specialization in a number of majors and minors.

A pre-professional program is offered for students preparing for medical, dental, or veterinary or other health career schools.

The College of Science actively fosters dialogue and joint research among campus scientists through special institutes and symposia. The Institute for Cellular and Molecular Biology (see catalog section on Special University Centers) and the Institute for Advanced Systems Studies are particularly active in these areas.

An active co-curricular program includes the Science Council; Beta Beta Beta Biological honor society; Biological Sciences Club; Microbiology Club; a chapter of Kappa Mu Epsilon (mathematics); a chapter of student affiliates of the American Chemical Society; Society of Physics Students; Sigma Pi Sigma, national honor society in physics; Upsilon Pi Epsilon, national honor society in Computer Science; the Geology Club and other organizations.

The College of Science supports the concept of international education and encourages students to investigate opportunities for overseas study. Certain courses taken at CSU International Program study centers in foreign countries are equivalent to courses in the College of Science and may be used to fulfill some of the degree requirements offered by the College and/or certain general education requirements. Students should consult the International Programs Bulletin, available at the International Center, a department advisor or the campus International Programs Coordinator for more information.

Interdisciplinary General Education (IGE)

Students majoring in the various programs in science are encouraged to take part of their General Education requirements through the Interdisciplinary General Education Program (IGE). This IGE program is specially designed to meet the needs of science students particularly in the areas of writing, critical thinking, humanities and the social sciences.

ENVIRONMENTAL HEALTH SPECIALIST MINOR

The Environmental Health Specialist Minor is an interdisciplinary program which may be pursued by majors in any field. Its purpose is to prepare students for careers as Environmental Health Specialist by meeting the standards for the state internship program. State employed specialists enforce and administer laws governing (water, food and air contamination) noise, land use planning, occupational health hazards, and animal vectors of disease. The minor is particularly suitable for students majoring in Biology, Microbiology, Zoology and Agricultural Biology.

A full description of the minor is in the "University Programs" section of this catalog.

PHYSIOLOGY MINOR

The Physiology Minor is an interdisciplinary program which can be elected by students majoring in any field. Its purpose is to improve the training and advising of students in order to facilitate their pursuit of careers in biomedical fields utilizing a knowledge of Physiology. It is particularly appropriate for students majoring in Animal Science, Behavioral Sciences, Biology, Chemistry, Electrical and Computer Engineering (Biomedical Engineering), Foods and Nutrition, Kinesiology, Microbiology and Zoology.

A full description of the minor is located in the "University Programs" section of this catalog.

Departments and Majors

BIOLOGICAL SCIENCES

Gilbert D. Brum, *Chair*

Biology major (BS); Biotechnology major (BS); Botany major (BS); Microbiology major (BS): Option in Microbiology, Option in Medical Technology; Zoology major (BS).

Minors in Botany, Plant Biotechnology, Plant Pathology, Microbiology, Zoology, Environmental Health Specialist, Physiology and Comparative Systems Analysis.

Master of Science in Biological Sciences.

CHEMISTRY

Keith Howard, *Chair*

Chemistry major (BS) Option in Chemistry; Option in Chemical Sciences; Option in Industrial Chemistry

Minor in Chemistry

Master of Science in Chemistry

COMPUTER SCIENCE

Barry I. Soroka, *Chair*

Computer Science major (BS)

Minors in Computer Systems Organization, Scientific Computer Programming and Artificial Intelligence

Master of Science in Computer Science

GEOLOGICAL SCIENCES

John A. Klasik, *Chair*

Geology Major (BS); Earth Sciences Major (BA)

Minor in Geology

MATHEMATICS

Claudia Pinter-Lucke, *Acting Chair*

Mathematics Major (BS); Option in Pure Mathematics; Option in Applied Mathematics; Option in Statistics;

Minors in Statistics and Mathematics

Master of Science in Mathematics

PHYSICS

Steven W. McCauley, *Chair*

Physics Major (BS)

Physics Minor

Center For Education and Equity in Mathematics, Science and Technology

The Center's purpose is to contribute to the improvement of science and mathematics education in elementary and secondary schools. To this end it coordinates workshops and courses for K-12 teachers and also provides teachers with equipment and other materials for use in their classrooms. For information see Judith Jacobs (3-243).

Cooperative Education

This program combines classroom study with closely related work experience. Its basic purpose is to provide a means whereby a student can combine study at Cal Poly with work experience. For information see Dr. J. Ernest Simpson (3-233).

Science Educational Enhancement Services

The objective of Science Educational Enhancement Services (SEES) is to increase the number of Blacks, Hispanics and American Indians in the sciences and mathematics. The program strives for the retention and graduation of its members by establishing a supportive community among students with these ethnic backgrounds and having technical career goals. SEES services include special faculty advisors in each department of the college, an orientation course for members who are new to the campus, a study center where students can work together, priority consideration to participate in Academic Excellence Workshops (see below) and clubs for preprofessional students from targeted ethnic groups. For information see Dr. Paul Hiemenz (3-222).

Academic Excellence Workshops

An Academic Excellence Workshop is a supplement to certain beginning-level chemistry, mathematics, computer science, physics and engineering courses which is open by invitation only. Participants in MEP in the College of Engineering and SEES in the College of Science receive priority consideration as invitees. The Workshop program promotes technical excellence in the subject area while also developing student and communication skills under the guidance of a trained facilitator. An invitation to participate should be regarded as an honor and a unique opportunity.

Pre-Professional Preparation (Pre-Dental, Pre-Medical, Pre-Veterinary, Other)

A science major is often very suitable for undergraduate preparation for medical, dental, veterinary and other professional schools. The list below summarizes the basic requirements for most professional schools. Requirements for a particular school may vary. Students who are interested in pre-professional preparation should consult with the pre-professional advisor, Dr. David Steele.

Recommended Courses

Freshman English I	ENG	104	(4)
Freshman English II	ENG	105	(4)
Basic Biology	BIO	115/115L	(5)
Cell, Molecular and Developmental Biology	BIO	310	(4)
Vertebrate Zoology	ZOO	138/138L	(5)
College Chemistry	CHM	104	(3)
College Chemistry	CHM	105	(3)
College Chemistry and	CHM	106	(3)
College Chemistry Lab	CHM	141L	(1)
College Chemistry Lab	CHM	142L	(1)
College Chemistry Lab or	CHM	143L	(1)
General Chemistry	CHM	111	(3)
General Chemistry	CHM	112	(3)
General Chemistry and	CHM	113	(3)
General Chemistry Lab	CHM	151L	(1)
General Chemistry Lab	CHM	152L	(1)
General Chemistry Lab	CHM	153L	(1)
Organic Chemistry	CHM	314	(3)
Organic Chemistry	CHM	315	(3)
Organic Chemistry	CHM	316	(3)
Organic Chemistry Lab	CHM	317L	(1)
Organic Chemistry Lab	CHM	318L	(1)
Organic Chemistry Lab	CHM	319L	(1)
College Physics	PHY	121	(3)
College Physics	PHY	122	(3)
College Physics	PHY	123	(3)
College Physics Lab	PHY	141L	(1)
College Physics Lab	PHY	142L	(1)
College Physics Lab	PHY	143L	(1)

For additional recommended and support courses, see Preprofessional Advisor: Chief Health Professions Advisor Dr. David Steele— Medicine, Dentistry, Veterinary, etc.

COLLEGE OF SCIENCE COURSE DESCRIPTIONS

SCI 110/110A Success in Science (1/1) FW

Orientation to the various majors in the College of Science. Exploration of student and University expectations of science majors. Career opportunities. One-to-one interaction with departmental mentors. Speakers, field trips. Open only to students in Science Educational Enhancement Services (SEES). May be repeated for a maximum of 4 units. 1 lecture, 1 two-hour activity. Concurrent enrollment required.

SCI 210/210L Physics Concepts and Activities (3/1) FW

Introduction to physics concepts, covering mechanics, heat, sound, light, electricity, magnetism and properties of matter. Laboratory and demonstration activities appropriate for elementary school teachers are emphasized. 3 lectures, 1 three-hour lab. Concurrent enrollment required. Prerequisite: MAT 191.

SCI 211/211L Chemical Sciences (3/1) WSP

The basic concepts of chemistry and an overview of the applications of chemistry from atomic theory through biochemistry. Laboratory activities include fundamental experiments that can be adopted for elementary school teaching. 3 lectures, 1 three-hour lab. Concurrent enrollment required.

SCI 212/212L Geological Sciences (3/1) Sp

Foundations in the science of Geology and Earth Science with emphasis on applications important in teaching. Lab sessions emphasize experiments useful for elementary school teachers. 3 lectures, 1 three-hour lab. Concurrent enrollment required.

SCI 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

SCI 450 Philosophic Implications of Science (4) Sp

Reading and discussion of works of eminent scientists and philosophers concerning those results of science that have a bearing on philosophic problems. Readings may be from authors such as Schrodinger, Russell, Huxley, Chardin, Kuhn. 4 lectures. Prerequisite: senior standing in one of the natural or physical sciences, mathematics or consent of the instructor.

SCI/EGR 460 Problems in Oceanographic Studies (3-5)

Course offered in conjunction with the Southern California Ocean Studies Consortium (SCOSC). Topics vary each term. See chair of Biological Sciences Department for further information. Upper division standing and permission of instructor required.

SCI 470, 471, 472, 473 Cooperative Education (2–4)

Part-time or full-time work experience that applies scientific principles to practice. To be taken in sequence. Prerequisite: Junior standing or approval of co-op coordinator. The work assignment must have prior approval. Maximum 16 units.

SCIENCE AND MATHEMATICS EDUCATION COURSE DESCRIPTIONS

SME 501 Mathematics and Sciences Learning for Adults (3)

Mathematics and sciences learning theories including cognitive, metacognitive and affective variables in learning mathematics and sciences. Adult development and adult learning theories. Diversity in mathematics and sciences instruction. 3 lecture/discussions.

SME 502L Practicum for College Mathematics and Science Faculty (3)

Development and practice of organizational and andragogical skills appropriate for the college mathematics or science instructor. 3 laboratory-discussions. Prerequisite: SME 501 and a concurrent teaching assignment in a college mathematics or science class.

SME 503 Issues in Higher Education for College Faculty (3)

The historical development of higher education: the California Master Plan; campus and system governance; the role of the faculty; educational and organizational responses to diversity, access, equity and excellence at the post-secondary level; student subgroups and the chancing demographics. 3 lecture/discussions.

BIOLOGICAL SCIENCES

Majors in Biology, Biotechnology, Botany, Microbiology, and Zoology

Gilbert D. Brum, *Chair*

Jill P. Adler	Glenn H. Kageyama
Keith E. Arnold	George W. Martinek
Jonathan N. Baskin	Larry K. McKane
Jack L. Bath	Edward K. Mercer
Kristin R. Bozak	David J. Moriarty
Stephen H. Bryant	Bijay K. Pal
David P. Campbell	Ronald D. Quinn
Gary C. Carlton	Fred Shafia
Peter Castro	Pamela J. Sperry
John K. Chan	David F. Steele
J. Curtis Clark	Glenn R. Stewart
Ronald S. Daniel	Daniel F. Stiffler
Bruce L. Firstman	Martin F. Stoner
Chris D. George	Laszlo J. Szijj
Donald F. Hoyt	Lenard R. Troncale
James O. Jackson	

The Biological Sciences Department offers bachelor degree programs in Biology, Biotechnology, Botany, Plant Biotechnology, Microbiology, and Zoology. In addition, minors in Botany, Plant Pathology, Microbiology, and Zoology are offered, and the department participates in interdisciplinary minors in Comparative System Analysis, Environmental Health Specialist, Physiology, and Quantitative Research. Departmental facilities include a molecular biology laboratory, greenhouses, controlled environmental units, a radiation biology laboratory, plant and animal collections, and an electron microscope facility. Ecological studies are facilitated by accessibility to natural habitats on campus and by the university's proximity to desert, mountain, and seashore areas. Courses in marine and fresh water biology provide preparation for teaching, conservation, wildlife management, or graduate research in aquatic biology. Courses in marine biology interact with the Ocean Studies Consortium of the CSU. A variety of field biology courses utilize the CSU Desert Studies Center at Zzyzx, near Baker, California. Students majoring in biological sciences and who have at least a 3.0 GPA have the opportunity to join Beta Beta Beta, an honorary society in the Biological Sciences Department. For additional information contact the department office.

A cumulative 2.0 GPA is required in core courses in all Biological Sciences majors in order to receive a degree in that major.

ENVIRONMENTAL HEALTH SPECIALIST MINOR

The Environmental Health Specialist Minor is an interdisciplinary program which may be pursued by majors in any field. Its purpose is to prepare students for careers as Environmental Health Specialists by meeting the standards for the state internship program. State-employed specialists enforce and administer laws governing water, food, and air contamination, noise, land use planning, occupational health hazards, and animal vectors of disease. The minor is particularly suitable for students majoring in the biological sciences. A full description of the minor is in the "University Programs" section of this catalog.

PHYSIOLOGY MINOR

The Physiology Minor is an interdisciplinary program which can be elected by students majoring in any field. Its purpose is to improve the training and advising of students in order to facilitate their pursuit of careers in biomedical fields utilizing a knowledge of physiology. It is particularly appropriate for students majoring in the biological sciences. A full description of the minor is located in the "University Programs" section of this catalog.

QUANTITATIVE RESEARCH MINOR

The Quantitative Research Minor is an interdisciplinary program which can be taken by students majoring in any field other than Mathematics. Its purpose is to prepare students to conduct quantitative analyses in their chosen discipline. Students acquire practical experience using statistics, principles of experimental design, survey and data analysis techniques. This minor is particularly suited for students majoring in the biological sciences. A full description of this minor is included in the "University Programs" section of this catalog.

BIOLOGY MAJOR

The Biology major stresses a balance between the theoretical aspects of biology and actual experience in field and laboratory. The variety of courses offered in a flexible curriculum provides an opportunity for a wide range of experience in both animal and plant sciences.

The offerings of this curriculum provide the student with a preparation for graduate and professional schools in fields ranging from molecular to field biology. The curriculum prepares prospective teachers for the secondary education credential. Graduate courses enable students to complete requirements for the junior college credential. For those planning a career as a secondary school teacher a credential is required. See Dr. George Martinek for additional information.

Core Course for Major

(Required of all students)

Scientific Communication I	BIO	190	(1)
Env. Conservation	BIO	201	(3)
Biometrics	BIO	211	(3)
Principles of Evolution	BIO	213	(4)
Genetics	BIO	303	(4)
Cell, Molecular, and Dev. Biol	BIO	310	(4)
Principles of Ecology	BIO	325/325L	(4)
Cellular Physiology	BIO	435/435L	(5)
or Plant Physiology	BOT	422/422L	(5)
or Comparative Animal Physiology	ZOO	424/424L	(5)
Scientific Comm II	BIO	490	(1)
Plant Structures and Functions	BOT	124/124L	(5)
Plant Morphology	BOT	125/125L	(5)
Basic Microbiology	MIC	201/201L	(5)
Invertebrate Zoology	ZOO	137/137L	(5)
Vertebrate Zoology	ZOO	138/138L	(5)
Upper Division courses in Biological Sciences			(12)

Support and Elective Courses

(Required of all students)

College Chemistry	CHM	105	(3)
College Chemistry	CHM	106	(3)
College Chemistry Laboratory	CHM	141L	(1)
College Chemistry Lab	CHM	142L	(1)
College Chemistry Lab	CHM	143L	(1)
Organic Chemistry	CHM	201	(3)
Organic Chemistry Lab	CHM	250L	(1)
Elements of Biochemistry	CHM	321/L	(4)
College Physics	PHY	121	(3)
College Physics	PHY	122	(3)
College Physics	PHY	123	(3)
College Physics Lab	PHY	141L	(1)
College Physics Lab	PHY	142L	(1)
College Physics Lab	PHY	143L	(1)
Intro to Statistics	STA	120	(4)
Approved electives			**(15)
Free Electives			(12-13)

Students considering graduate work or professional schools, see recommended courses for pre-professional preparation. (p. 445)

** Approved electives include all 200, 300, and 400-level courses in the biological sciences not specifically designed for nonmajors. The year series of

Organic Chemistry and Biochemistry are also included for approved electives. See advisor for approval of courses offered by other departments.

General Education Courses

Area 1:

A. Freshman English I	.ENG	104	(4)
B. Advocacy and Argument	.COM	204	(4)
C. Freshman English II	.ENG	105	(4)

Area 2:

A. Calculus for Life Science	.MAT	120	(4)
B. College Chemistry	.CHM	104	(3)
C. Basic Biology	.BIO	115/115L	(5)
D. Select from approved list			(4)

Area 3:

Select one course from each subarea (A-F) .... (24)
Select one of the following for Subarea G:
BIO 205, 203 or
PSY 201 or PSY 210 .... (4)

Area 4:

United States History	.HST	202	(4)
Intro to American Government	.PLS	201	(4)

Area 5:

Select two courses from approved list. Must be outside the Bio Sci department .... (8)

BIOTECHNOLOGY MAJOR

The Biotechnology major is an interdisciplinary program which provides students with a strong background in both biology and chemistry. It provides the theoretical and practical knowledge needed to understand the numerous industrial applications of biological phenomena, while emphasizing the study of cell and molecular biology. Students can select their upper division electives from six clusters: 1) Physiology; 2) Molecular Biology and Genetics; 3) Microbiology and Pathology; 4) Biochemistry and Molecular Separation Techniques; 5) Agriculture; and, 6) Business. Twenty-three units will be chosen from one of these clusters (referred to as the student's Primary cluster) and an additional 14 units from the other five clusters. This will allow the individual to specialize in a particular area. An important feature of this major is the internship in a biotechnology laboratory which will provide practical experience in the field. This program also satisfies the requirements for acceptance to various graduate and preprofessional schools. This major requires admission to the Biological Sciences Department and completion of the 198-199 units indicated below. There are no special admission requirements. The Biological Sciences Department also offers a curriculum leading to the Master of Science in Biology with emphasis in Biotechnology.

Core Courses for Major

Biometrics	.BIO	211	(3)
Horizons in Biotechnology	.BIO	230	(1)
Computer Applications in Biology	.BIO	256/256L	(2)
Genetics	.BIO	303	(4)
Cell, Molecular, & Dev. Biology	.BIO	310	(4)
Internship in Biology	.BIO	441	(2)
or Cooperative Education	.SCI	470	(2)
Concepts of Molecular Biology	.BIO	450	(4)
Molecular Biology Techniques	.BIO	451/451L	(5)
Scientific Comm II	.BIO	490	(1)
or Undergraduate Seminar	.CHM	493	(2)
College Chemistry	.CHM	105	(3)
College Chemistry	.CHM	106	(3)
College Chemistry Laboratory	.CHM	141L	(1)
College Chemistry Laboratory	.CHM	142L	(1)
College Chemistry Laboratory	.CHM	143L	(1)
Quantitative Analysis	.CHM	221	(4)
Organic Chemistry	.CHM	314	(3)

Organic Chemistry	.CHM	315	(3)
Organic Chemistry	.CHM	316	(3)
Organic Chemistry Lab	.CHM	317L	(1)
Organic Chemistry Lab	.CHM	318L	(1)
Organic Chemistry Lab	.CHM	319L	(1)
Biochemistry	.CHM	329/329L	(4)
Basic Microbiology	.MIC	201/201L	(5)
Vertebrate Zoology	.ZOO	138/138L	(5)
or Plant Structure & Function	.BOT	124/124L	(5)
or Plant Morphology	.BOT	125/125L	(5)
Upper Division Courses			(37)

At least 23 units from one ("Primary") cluster and 14 units from any of the other five clusters, to be selected in consultation with faculty advisor. See clusters listed below under "Upper Division Course Clusters".

Support Courses

College Physics	.PHY	121	(3)
College Physics	.PHY	122	(3)
College Physics	.PHY	123	(3)
College Physics Lab	.PHY	141L	(1)
College Physics Lab	.PHY	142L	(1)
College Physics Lab	.PHY	143L	(1)
Technical Calculus II	.MAT	131	(4)
Technical Calculus III	.MAT	132	(4)
Statistics with Applications	.STA	120	(4)

General Education Courses

Area 1:

A. Freshman English I	.ENG	104	(4)
B. Freshman English II	.ENG	105	(4)
C. Advocacy and Argument	.COM	204	(4)

Area 2:

A. Technical Calculus I	.MAT	130	(4)
B. College Chemistry	.CHM	104	(3)
C. Basic Biology	.BIO	115/115L	(5)
D. Choose one from approved list			(4)

Area 3:

Select one course from each subarea (A-F) .... (24)

Subarea G. General Psychology	.PSY	201	(4)

Area 4:

U.S. History	.HST	202	(4)
Intro American Gov	.PLS	201	(4)

Area 5:

Biochemistry	.CHM	327/327L	(4)
Biochemistry	.CHM	328/328L	(4)
Total Units in General Education			72
Total Units All Courses			198-199

Course Descriptions.

See course descriptions under appropriate department.

Upper Division Course Clusters

Cluster 1 – Physiology

Cellular Physiology	.BIO	435/435L	(5)
Endocrinology **	.BIO	520/520L	(4)
Renal Physiology **	.BIO	521	(3)
Advanced Plant Physiology	.BIO	548/548L	(4)
Bacterial Physiology **	.BIO	560/560L	(4)
Plant Physiology	.BOT	422/422L	(5)
Plant Anatomy	.BOT	435/435L	(4)
Fundamentals of Physical Chemistry	.CHM	301	(4)
Nutrient Biochemistry and Metabolism	.CHM	454	(3)
Biomedical Instrumentation	.ECE	435	(3)

Biomedical Instrumentation Lab . . . . .ECE	485	(1)
Advanced Nutrition . . . . .FN	433	(4)
Biophysics . . . . .PHY	410	(3)
Comparative Animal Physiology . . . . .ZOO	424/424L	(5)
Histology . . . . .ZOO	422/422L	(5)

Cluster 2 - Molecular Biology & Genetics

Plant Breeding . . . . .AGR	404L	(4)
Population Genetics . . . . .BIO	445/L	(4)
Advanced Genetics . . . . .BIO	421	(3)
Recombinant DNA Techniques . . . . .BIO	455/455L	(4)
Cytogenetics ** . . . . .BIO	510/510L	(3)
Advanced Cell Biology ** .BIO	535	(4)
Plant Growth & Development ** . . . . .BIO	550/550L	(4)
Molecular Biology of Development ** . . . . .BIO	555	(3)
Animal Tissue Culture ** .BIO	565/565L	(4)
Transmission Electron Microscopy ** . . . . .BIO	577/577L	(5)
Scanning Electron Microscopy ** . . . . .BIO	578/578L	(5)
Plant Genetics . . . . .BOT	403/403L	(4)
Plant Tissue Culture . . . . .BOT	456/456L	(3)
Human Genetics . . . . .BIO	403/L	(4)
Recombinant DNA Biochemistry . . . . .CHM	453	(3)
Microbial Structures & Function . . . . .MIC	300/300L	(5)
Biophysics . . . . .PHY	410	(3)

Cluster 3 - Microbiology & Pathology

Radiation Biology . . . . .BIO	431/431L	(5)
Cellular Immunity & Disease ** . . . . .BIO	570/570L	(4)
Advanced Immunology ** . . . . .BIO	576/576L	(3)
Plant Pathology . . . . .BOT	323/323L	(4)
Mycology . . . . .BOT	426/426L	(4)
Methods in Plant Pathology . . . . .BOT	441/441L	(4)
Microbial Structures & Functions . . . . .MIC	300/300L	(5)
Immunology-Serology . . . . .MIC	415/415L	(5)
Medical Microbiology . . . . .MIC	419	(5)
Medical Mycology . . . . .MIC	425/425L	(5)
General Virology . . . . .MIC	430/430L	(5)
Hematology . . . . .MIC	444/444L	(4)

Cluster 4 - Biochemistry and Molecular Separation Techniques

Elements of Physical Chemistry . . . . .CHM	304	(4)
Elements of Physical Chemistry . . . . .CHM	305	(4)
The Chemist in Industry . . . . .CHM	340	(4)
Spectroscopic Methods . . . . .CHM	342	(4)
Separation Methods . . . . .CHM	343	(4)
Electroanalytical Methods . . . . .CHM	344	(4)
Theory of Chemical Instrumentation . . . . .CHM	347	(2)
Physical Chemistry Laboratory . . . . .CHM	352	(3)
Organic Analysis . . . . .CHM	424	(4)
Enzymology . . . . .CHM	451	(4)
Biochemical Preparations .CHM	452	(3)
Recombinant DNA Biochemistry . . . . .CHM	453	(3)
Biochemical Mechanisms ** . . . . .CHM	565	(3)
Advanced Clinical Chemistry** . . . . .CHM	567	(3)

Cluster 5 - Agriculture

Food Processing Engineering . . . . .AE	332	(4)
Plant Growth Regulators .AGB	470L	(3)
Mammalian Endocrinology . . . . .AS	412	(4)
Design and Analysis of Experimental Research ** . . .AS	545	(4)
Food Science and Technology . . . . .FN	317	(4)
Food Chemistry and Toxicology . . . . .FN	420	(4)
Advanced Plant Propagation . . . . .HOR	422	(4)
Soil Chemistry . . . . .SS	431L	(4)
Immunological Procedures in Animal Production . . . .VS	405	(4)

Cluster 6 - Business

Special Topics . . . . .BUS	499	(2)
Management Information Systems . . . . .CIS	310	(4)
Principles of Management .MHR	301	(4)
Organizational Behavior in Multicultural Env . . . . . .MHR	318	(4)
Management Policies and Systems . . . . .MHR	410	(4)
Principles of Marketing Management . . . . .MKT	301	(4)
Production and Operations Management I . . . . .OM	331	(4)

**500-level courses: No more than 13 units may be counted toward an under-graduate degree. Students must have a 2.75 GPA, have senior standing, and file a special petition to receive undergraduate (or graduate) credit for graduate courses taken as a senior.

BOTANY MAJOR

The Botany curriculum offers a four-year sequence of foundation courses plus electives to provide the fundamentals of plant sciences as well as the flexibility to permit selection of courses for several lines of study. Such versatility covers the major disciplines of plant science—physiology, morphology and systematics, and also provides for careers in mycology, pathology, ecology, field biology, plant biotechnology and similar occupational areas which require a strong background of basic plant studies.

Of considerable advantage to the program are the various distinct plant communities available nearby for field study.

Other centers of botanical study and resources close at hand include the Los Angeles State and County Arboretum, Huntington Botanical Garden, and the Rancho Santa Ana Botanic Garden.

Core Courses for Major

(Required of all students)

Scientific Communication .BIO	190	(1)
Principles of Evolution . . . . .BIO	213	(4)
Genetics . . . . .BIO	303	(4)
Cell, Molecular, and Dev. Biol . . . . .BIO	310	(4)
Principles of Ecology . . . . .BIO	325/325L	(4)
Scientific Comm II . . . . .BIO	490	(1)
Plant Structures and Functions . . . . .BOT	124/124L	(5)
Plant Morphology . . . . .BOT	125/125L	(5)
Gen. Plant Pathology . . . . .BOT	323/323L	(4)
Plant Taxonomy . . . . .BOT	436/436L	(4)
Plant Ecology . . . . .BOT	421/421L	(4)
Plant Physiology . . . . .BOT	422/422L	(5)
Phycology . . . . .BOT	433/433L	(4)
or Mycology . . . . .BOT	425/425L	(4)
or Mycology . . . . .BOT	426/426L	(4)
Plant Anatomy . . . . .BOT	435/435L	(4)
Basic Microbiology . . . . .MIC	201/201L	(5)
Invertebrate Zoology . . . . .ZOO	137/137L	(5)
Vertebrate Zoology . . . . .ZOO	138/138L	(5)

Support and Elective Courses

(Required of all students)

College Chemistry . . . . .CHM	105	(3)
College Chemistry . . . . .CHM	106	(3)
College Chemistry Lab. . . . . .CHM	141L	(1)
College Chemistry Lab . . . . .CHM	142L	(1)
College Chemistry Lab . . . . .CHM	143L	(1)
Organic Chemistry . . . . .CHM	201	(3)
Organic Chemistry Lab . . . . .CHM	250L	(1)
Elements of Biochemistry .CHM	321	(4)
Calculus for Life Science .MAT	120	(4)
College Physics . . . . .PHY	121	(3)
College Physics . . . . .PHY	122	(3)
College Physics . . . . .PHY	123	(3)

College Physics Lab	.PHY	141L	(1)
College Physics Lab	.PHY	142L	(1)
College Physics Lab	.PHY	143L	(1)
Basic Soil Science	.SS	231/231L	(4)
Approved Electives		**	(21)
Free Electives			(4)

Students considering graduate work or professional schools, see recommended courses for preprofessional preparation.

** Approved electives include any 200, 300, and 400-level courses in the Biological Sciences Department not specifically designed for non-majors. Approved electives also include : all 200, 300 and 400-level chemistry courses; PHY 304, 340 and 410; MAT 114, 115 and 116; HOR 131, 323, 422 and 427; AGR 220, 331, 404 and 421; STA 120. See advisor for approval of other courses offered by other departments.

General Education Courses

Area 1:
A. Freshman English I	.ENG	104	(4)
B. Advocacy and Argument	.COM	204	(4)
C. Freshman English II	.ENG	105	(4)

Area 2:
A. Calculus for Life Science	.MAT	105	(4)
B. College Chemistry	.CHM	104	(3)
C. Basic Biology	.BIO	115/115L	(5)
D. Select from approved list			(4)

Area 3:
Select one course from each subarea (A- F)..................... (24)

Subarea G
Select one of the following:
BIO 205, KIN/FN 203, PSY 201, or PSY 210 .... (4)

Area 4:
U.S. History	.HST	202	(4)
Intro American Gov	.PLS	210	(4)

Area 5:
Select two courses from approved list. Must be outside the
Biological Sciences Dept .... (8)
(SEE ADVISOR)

BOTANY MINOR

Required Courses (all students)
Minimum units—32
Minimum upper division units—12

Basic Biology	.BIO	115/115L	(5)
Plant Structures and Functions	.BOT	124/124L	(5)
and Plant Morphology	.BOT	125/125L	(5)

and 6 units of BOT prefix courses
not including FBOT 316
At least three of the following courses must be completed:

Plant Pathology	.BOT	323/323L	(4)
California Flora	.BOT	343/343L	(3)
Plant Ecology *	.BOT	421/421L	(4)
Plant Physiology **	.BOT	422/422L	(5)
Plant Anatomy	.BOT	435/435L	(4)

Any of the following courses may be used to complete the minor:

Principles of Evolution	.BIO	213	(4)
Genetics	.BIO	303	(4)
Plant Nematology	.BOT	423/423L	(4)
Principles of Ecology	.BIO	325/325L	(4)
Mycology	.BOT	425/425L	(4)
Mycology	.BOT	426/426L	(4)
Phycology	.BOT	433/433L	(4)

Morphology of Embryophytes	.BOT	434/434L	(5)
Plant Taxonomy	.BOT	436/436L	(4)
Diagnosis and Control of Plant Diseases	.BOT	440/440L	(4)
Methods in Plant Pathology	.BOT	441/441L	(4)
Elements of Organic Chemistry	.CHM	201	(3)
Organic Chemistry ***	.CHM	314	(3)

*Prerequisite: BIO 325.
**Prerequisite: CHM 201 or consent of instructor.
***CHM 317 must be taken concurrently.

Note: This minor may not be earned by Botany majors, nor can both Botany and Plant Pathology minors be earned by one student.

PLANT BIOTECHNOLOGY MINOR

May be taken by students majoring in Botany.

The following courses are required for the minor.

Plant Pathology *	.BOT	323/323L	(4)
Plant Genetics * **	.BOT	403/403L	(4)
Plant Physiology *	.BOT	422/422L	(5)

Any of the following courses may be taken to complete the minor.

Seed Production **	.AGR	331/L	(4)
Plant Breeding **	.AGR	404/L	(4)
Concepts of Molecular Biology	.BIO	450	(4)
Molecular Biology Techniques	.BIO	451/451L	(5)
Mycology	.BOT	426/426L	(4)
Methods in Plant Pathology	.BOT	441/441L	(4)
Plant Tissue Culture	.BOT	456/456L	(3)

Minimum units: 30
*Prerequisite: BOT 124.
**Prerequisite: BIO 115/L
***Prerequisites: AGR 122 and AGR 221 or AGR 226.

PLANT PATHOLOGY MINOR

May be taken by students majoring in Botany.

Required Courses (all students)
Minimum units—32
Minimum upper division units—12

The following courses are required for the minor.

Basic Biology	.BIO	115/115L	(5)
Plant Structures and Functions	.BOT	124/124L	(5)
or Plant Morphology	.BOT	125/125L	(5)
Plant Pathology	.BOT	323/323L	(4)
Diagnosis and Control of Plant Diseases	.BOT	440/440L	(4)
or Methods in Plant Pxathology	.BOT	441/441L	(4)

At least two of the following courses must be completed in addition.

Diagnosis and Control of Plant Diseases	.BOT	440/440L	(4)
Methods in Plant Pathology	.BOT	441/441L	(4)
Plant Anatomy	.BOT	435/435L	(4)
Mycology	.BOT	425/425L	(4)
Plant Physiology*	.BOT	422/422L	(5)
Mycology	.BOT	426/426L	(4)

Any of the above or following courses may be used to complete the minor.

Plant Nematology	.BOT	423/423L	(4)
Diseases of Ornamental Plants	.HOR	427/L	(4)
Diagnosis of Ornamental Plant Growth Problems	.HOR	43/7L	(4)
Crop Diseases	.AGR	421/L	(4)

*Prerequisite: CHM 201 or consent of instructor.
**Prerequisite: FI 102.

MICROBIOLOGY MAJOR

The Microbiology major chooses one of the two options offered by the section, microbiology or medical technology. The core courses of the major provide a strong background in various areas of biology to better prepare students for their chosen field. The program offered in the microbiology section constitutes excellent undergraduate training and can also be oriented toward the preprofessional fields.

Completion of the medical technology option satisfies the eligibility requirements established by the California State Department of Health and the Registry of Medical Technologists of the American Society of Clinical Pathologists (ASCP) for acceptance into a one year clinical traineeship at an approved School of Medical Technology.

Core Courses for Major

(Required of all students)

Scientific Communication I	.BIO	190	(1)
Genetics	.BIO	303	(4)
Scientific Comm II	.BIO	490	(1)
Plant Morphology	.BOT	125/125L	(5)
Basic Microbiology	.MIC	201/201L	(5)
Microbial Structures and Functions	.MIC	300/300L	(5)
Medical Bacteriology	.MIC	410/410L	(5)
Immunology-Serology	.MIC	415/415L	(5)
General Virology	.MIC	430/430L	(5)
Invertebrate Zoology	.ZOO	137/137L	(5)
Vertebrate Zoology	.ZOO	138/138L	(5)

Option Courses for Major

(Required for specific option)

Microbiology Option

Cellular Physiology	.BIO	435/435L	(4)
Concepts of Molecular Biology	.BIO	450	(4)
Plant Structures and Functions	.BOT	124/124L	(5)
Applied Microbiology	.MIC	310/310L	(5)
Approved electives to be chosen in consultation with advisor **			(11-12)

Medical Technology Option

Clinical Chemistry	.CHM	331/331L	(4)
Medical Mycology	.MIC	425/425L	(5)
Hematology	.MIC	444/444L	(4)
Immunohematology	.MIC	445/445L	(4)
Human Anatomy	.ZOO	234/234L	(4)
Human Physiology	.ZOO	235/235L	(4)
Medical Parasitology	.ZOO	425/425L	(5)

Support and Elective Courses

(Required of all students)

College Chemistry	.CHM	105	(3)
College Chemistry	.CHM	106	(3)
College Chemistry Lab	.CHM	141L	(1)
College Chemistry Lab	.CHM	142L	(1)
College Chemistry Lab	.CHM	143L	(1)
Quantitative Analysis	.CHM	221	(4)
Organic Chemistry	.CHM	314	(3)
Organic Chemistry	.CHM	315	(3)
Organic Chemistry	.CHM	316	(3)
Organic Chemistry Lab	.CHM	317L	(1)
Organic Chemistry Lab	.CHM	318L	(1)
Organic Chemistry Lab	.CHM	319L	(1)
Biochemistry	.CHM	327/327L	(4)
Biochemistry	.CHM	328/328L	(4)
Biochemistry	.CHM	329/329L	(4)
College Physics	.PHY	121	(3)
College Physics	.PHY	122	(3)
College Physics	.PHY	123	(3)
College Physics Lab	.PHY	141L	(1)
College Physics Lab	.PHY	142L	(1)
College Physics Lab	.PHY	143L	(1)
Approved electives (Microbiology Option)			(15)
Approved electives (Medical Technology Option)			(3)

Students considering graduate work or professional schools, see recommended courses for preprofessional preparation (p. 441).

General Education Courses

Area 1:

A. Freshman English I	.ENG	104	(4)
B. Advocacy and Argument	.COM	204	(4)
C. Freshman English II	.ENG	105	(4)

Area 2:

A. Calculus for Life Science	.MAT	120	(4)
B. College Chemistry	.CHM	104	(3)
C. Basic Biology	.BIO	115/115L	(5)
D. Select from approved list			(4)

Area 3:

Select one course from each subarea (A-F) .... (24)

Subarea G. Select one of following:

BIO 205, KIN/FN 203, PSY 201, or
  Psy 210 .... (4)

Area 4:

U.S. History	.HST	202	(4)
Intro to American Gov:	.PLS	201	(4)

Area 5:

Select two courses from approved list. Must be outside the Biological Sciences Department .... (8)

MICROBIOLOGY MINOR

Minimum units—40

Note: This minor may not be earned by Microbiology majors.

Required Courses (all students)

Basic Biology	.BIO	115/115L	(5)
College Chemistry	.CHM	104	(3)
College Chemistry	.CHM	105	(3)
College Chem Lab	.CHM	141L	(1)
College Chem Lab	.CHM	142L	(1)
Elements Org Chem	.CHM	201	(3)
Elements of Org Chem Lab	.CHM	250L	(1)
Elements of Biochemistry	.CHM	321	(4)
Basic Microbiology	.MIC	201/201L	(5)
Microb Struc & Funct	.MIC	300/300L	(5)

At least two courses from the following list of courses:

Applied Microbiology	.MIC	310/310L	(5)
or Food Microbiology	.MIC	320/320L	
Medical Bacteriology	.MIC	410/410L	(5)
Immunology-Serology	.MIC	415/415L	(5)
Medical Mycology	.MIC	425/425L	(5)
General Virology	.MIC	430/430L	(5)

Other courses may be substituted for those listed above in consultation with all of the faculty in the microbiology section.

ZOOLOGY MAJOR

Qualified Zoology majors are prepared for employment in a variety of state and federal agencies dealing with fisheries, wildlife management, and related subjects.

The curriculum in zoology provides strong premedical, predental, and preveterinary preparation, as well as preparing the student for graduate studies in zoology.

Facilities include a large animal colony, a representative collection of living local reptiles and amphibians and an extensive study collection of bird, mammal, amphibian, reptile and fish specimens. Unique and extensive wild areas are available on the campus for animal studies.

Core Courses for Major

(Required of all students)

Scientific Communication I	.BIO	190	(1)
Biometrics	.BIO	211	(3)
Principles of Evolution	.BIO	213	(4)
Genetics	.BIO	303	(4)
Cell, Molecular, and Dev. Biol	.BIO	310	(4)
Principles of Ecology	.BIO	325/325L	(4)
Scientific Comm II	.BIO	490	(1)
Plant Structures and Functions	.BOT	124/124L	(5)
Plant Morphology	.BOT	125/125L	(5)
Basic Microbiology	.MIC	201/201L	(5)
Invertebrate Zoology	.ZOO	137/137L	(5)
Vertebrate Zoology	.ZOO	138/138L	(5)
Intro to Entomology	.ZOO	426/426L	(4)
Comparative Animal Physiology	.ZOO	424/424L	(5)

Each student will complete at least 5 upper division zoology (ZOO prefix) courses   (26)

Students considering graduate work or professional schools, see recommended courses for preprofessional preparation.

Support and Elective Courses

(Required of all students)

College Chemistry	.CHM	105	(3)
College Chemistry	.CHM	106	(3)
College Chemistry Lab	.CHM	141L	(1)
College Chemistry Lab	.CHM	142L	(1)
College Chemistry Lab	.CHM	143L	(1)
Organic Chemistry	.CHM	201	(3)
Organic Chemistry Lab	.CHM	250L	(1)
Elements of Biochemistry	.CHM	321	(4)
Elements of Biochemistry	.CHM	321L	(1)
College Physics	.PHY	121	(3)
College Physics	.PHY	122	(3)
College Physics	.PHY	123	(3)
College Physics Lab	.PHY	141L	(1)
College Physics Lab	.PHY	142L	(1)
College Physics Lab	.PHY	143L	(1)
Intro to Statistics	.STA	120	(4)
Approved Electives			(12)

Approved electives include any 200, 300, or 400 level courses in the Biological Sciences Department not specifically designed for non-majors. Approved electives also include: CHM 301, 314, 315, 316, 327, 328, 329, and MAT 114, 115, 116. See advisor for approval of courses offered by other departments.

General Education Courses

Area 1:

A. Freshman English I	.ENG	104	(4)
B. Advocacy and Argument	.COM	204	(4)
C. Freshman English II	.ENG	105	(4)

Area 2:

A. Calculus for Life Science	.MAT	120	(4)
B. College Chemistry	.CHM	104	(3)
C Basic Biology	.BIO	115/115L	(5)
D. Select from approved list			(4)

Area 3:

Select one course from each subarea (A-F) .... (24)

Subarea G. Select one of following:

BIO 205, KIN/FN 203, PSY 201 or PSY 210 .... (4)

Area 4:

U.S. History	.HST	202	(4)
Intro American Gov	.PLS	201	(4)

Area 5:

Choose two courses from approved list. Must be outside the Biological Sciences Department .... (8)

ZOOLOGY MINOR

Minimum units—32
Minimum upper division units—12
Note: This minor may not be earned by Zoology majors.
Required Courses (all students):

Basic Biology	.BIO	115/115L	(5)
Genetics	.BIO	303	(4)
Invertebrate Zoology	.ZOO	137/137L	(5)
Vertebrate Zoology	.ZOO	138/138L	(5)

Any two from the following courses:

Principles of Evolution	.BIO	213	(4)
Principles of Ecology	.BIO	325/325L	(4)
Comparative Animal Physiology	.ZOO	424/424L	(5)

At least two courses from the following list of courses to complete the minor:

Human Anatomy	.ZOO	234/234L	(4)
Human Physiology	.ZOO	235/235L	(4)
Ornithology	.ZOO	329/329L	(3)
Embryology	.ZOO	414/414L	(5)
Animal Behavior	.ZOO	419/419L	(3)
Histology	.ZOO	422/422L	(5)
Medical Parasitology	.ZOO	425/425L	(5)
Introduction to Entomology	.ZOO	426/426L	(4)
Herpetology	.ZOO	429/429L	(4)
Mammalogy	.ZOO	430/430L	(4)
Public Health Entomology	.ZOO	435/435L	(4)
Evolution of the Invertebrates	.ZOO	438/438L	(5)
Physiological Ecology of Animals	.ZOO	440/440L	(4)
Ichthyology	.ZOO	441/441L	(4)
Comparative Anatomy of Vert	.ZOO	451/451L	(5)

BIOLOGY COURSE DESCRIPTIONS

NOTE: For all courses which have both a lecture e component and a laboratory component (e.g. BIO 115/BIO 115L), both components are corequisites; that is, they must be taken concurrently.

When appropriate, the names of faculty associated with each course are specified; otherwise, "Staff" is noted. Courses approved for CR/NC grading are designated by + and apply only to majors outside the Biological Sciences Department.

BIO 100/100L Fundamentals of Biology (3/1)

A lecture/laboratory demonstration and discussion course dealing with various aspects of scientific investigation, environmental problems, population, genetics, evolution, physiology and other student selected topics. 3 lectures, 1 three-hour laboratory. Prerequisite: Consent of instructor. Staff.

BIO 110 Life Science (3)

Basic concepts in the study of living systems, including human beings. The study of biology will be used to illustrate approaches of science in understanding the universe. The role of science in modern society and the impact of human civilization on other organisms will be considered. Designed to satisfy the general education requirements for life science. 3 lectures. Staff.

BIO 111L Life Science Laboratory (1)

An optional laboratory to accompany BIO 110. A basic understanding of living organisms will be achieved through experiments and demonstrations. This course will satisfy the general education require-requirements for a laboratory course, 1 three-hour laboratory. Prerequisite: BIO 110 or concurrent enrollment in BIO 110. Staff.

BIO 115/115L Basic Biology (3/2)

Introduction to living things; basic structure and function of plants and animals and their relationship to the physical world. Designed as a prerequisite course for majors who take other courses in Biological Sciences. 3 lectures, 2 three-hour laboratories. Arnold, George.

Bio 190 Scientific Communication I (1)

An introduction to writing and information resources for biologists. One hour lecture/problem. Staff

BIO 200 Special Problems for Lower Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Enrollment requires: 1) Prior arrangement with a faculty member. 2) Completion of a supervisory form available only in the Biological Sciences Department office. Total credit for a degree in Biological Sciences is limited to 6 units OF BIO 200 and/or 400, with a maximum of 2 units per quarter. Staff.

+BIO 201 Environmental Conservation (3)

Contemporary environmental issues, and conservation of natural resources. Topics include ecological concepts, population, food, energy, water, wildlife, land use, and pollution. 3 lecture/problems. Prerequisite: BIO 110 or 115. Quinn, Stewart.

BIO 205 Biological Perspectives on Contemporary Life (4)

A course designed to enable students to make effective decisions for quality lifestyles by gaining practical knowledge and understanding of the roles that diet, stress, drugs, disease, heredity, sexuality, environmental pollution, and the normal life processes of aging and death play in our lives. 4 lecture/discussions. Prerequisite: BIO 110 or BIO 115/115L. George, Quinn.

BIO 211 Biometrics (3)

Applied statistical analysis of biological data. Understanding, interpreting, and performing data analysis in a research context. 3 lecture/problems. Prerequisite: BIO 115/L, and STA 120. Bryant, Moriarty.

BIO 213 Principles of Evolution (4)

Introduction to plant and animal evolution. 4 lecture/problems. Prerequisite: BIO 110 or 115/L. Bryant, Firstman, Troncale.

BIO 220/220L Introduction to Marine Biology (3/1)

Introduction to life in the oceans. General survey of its living resources, ecology of its major environments, impacts of man, and applications of technolo-gy to the exploitation of its living resources. 3 lecture/problems. 1 three-hour laboratory (several weekend field trips required). Arnold, Baskin, Castro.

BIO 230 Horizons in Biotechnology (1)

A survey of the various applications of biotechnology in today's industrial community. Topics include theoretical explanations of recent biotechnological developments, discussion of problems encountered in production, manufacturing, and marketing of new products, and future directions in biotechnological research. The course will feature guest lecturers from various biotechnological industries. 1 lecture. Adler.

BIO 256/256L Computer Applications in Biology (1/1)

Use of microcomputers in the acquisition, manipulation, and presentation of numeric and textual data in biology. 1 lecture/problem, 1 three-hour laboratory. Prerequisites: BIO 110 or BIO 115/L, CS 100 or CIS 101. Clark, Moriarty.

BIO 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture/problems, laboratory problems, or a combination of both. Staff.

BIO 300 Human Heredity (4)

Nontechnical introduction to hereditary principles with emphasis on humans. Hereditary diseases, blood types, mutations, radiation, and evolution. For nonmajors. 4 lecture/problems. Not for core or support credit for students with majors in the Biological Sciences Department. Prerequisite: BIO 110 or Bio 115/L. Bryant, Campbell, Martinek.

BIO 301 Human Sexuality (4)

Frank and factual coverage of human sexuality through discussions, lectures, films and guest speakers. Topics include sexual response and orgasm; myths and misconceptions; birth control; sex and the law; fertilization, pregnancy, and childbirth; diseases and dysfunctions; sex and drugs; genital structure and recent developments in the study of human sexuality. 4 lecture/problems. May be used for Approved Elective but not Upper Division Core credit by students with majors in the Biological Sciences Department. Adler, Daniel, George, McKane, Steele.

+BIO 302 Biology of Cancer (4)

Topics include causes and symptoms of cancer, molecular and cell biology of cancer, lung, skin and other major "site" cancers, chemotherapy, immunotherapy, present research and psychosocial aspects. Material is presented by guest lecturers including specialists and cancer patients. May be used for Approved Elective but not Upper Division Core credit by students with majors in the Biological Sciences Department. 4 lecture/problems. Prerequisites: BIO 110, or BIO 115/L or consent of instructor. Troncale.

BIO 303 Genetics (4)

Principles of heredity. Introduction to transmission genetics, cytogenetics, molecular genetics and population genetics. 4 lecture/problems. Prerequisite: BIO 110 or 115/115L. Bozak, Bryant, Campbell, Martinek, Troncale.

+BIO 305 Aquatic Ecology for Environmental Engineers (4)

Ecological principles and their application to productivity, pollution, and other problems with emphasis on natural and man-made aquatic habitats. Not for core or support credit for students with majors in the Biological Sciences Department. 4 lecture/problems. Prerequisite: BIO 110. Arnold, Mercer.

BIO 310 Cell, Molecular, and Developmental Biology (4)

Cellular processes and molecular interactions, including transport, chemical signaling, cell-cell adhesion, intercellular communication, support and movement, energy conversions, digestion, assembly of macro-molecules and

organelles, gene control in prokaryotes and eukaryotes; cellular mechanisms of development. 4 lecture/problems. Prerequisites: BIO 303 and CHM 106 or 113 and CHM 201 or 314/L. Bozak, Sperry, Troncale.

BIO 311 AIDS: Current Topics and Concerns (4)

Course covers prevalent sexually transmitted diseases in the United States with emphasis on AIDS. Topics covered include distribution, transmission, sexual practices, current research, effects on immune system, treatments, testing, counseling and availability of support groups. Selected topics will be presented by guest speakers. Open to all majors for credit/no credit. May be used for Approved Elective but not Upper Division Core credit by students with majors in the Biological Sciences Department. 4 lectures. Prerequisite: BIO 110, BIO 115/115L, or equivalent, or consent of instructor. Adler, George, Steele.

BIO 325/325L Principles of Ecology (3/1)

A study of ecosystems; the interactions between organisms and environment. 3 lecture/problems, 1 three-hour laboratory. 3 one-day weekend field trips. Prerequisite: BIO 115/115L and BIO 211, Bryant, Carleton, Moriarty, Quinn, Szijj.

BIO 333 Genetics Laboratory (1)

Hands on experience in collection and analysis of genetic data. Students will master methodologies for handling DNA, fruit flies and chromosomes. Solution of genetics problems using current analysis techniques. 1 three-hour laboratory. Prerequisite: BIO 303. Bryant, Troncale.

BIO 400 Special Problems for Upper Division Students (1–2)

Individual or group investigation of selected problems or supervised attendance for juniors and seniors at department seminars. Discussions and reports required. Enrollment requires: 1) Prior arrangement with a faculty member. 2) Completion of a supervisory form available from the Biological Sciences Department office. Total credit for a degree in biological sciences is limited to 6 units of BIO 200 and/or BIO 400, with a maximum of 2 units per quarter. Staff.

BIO 403/403L Human Genetics (3/1)

Study of single and multi gene human diseases, chromosome aberrations, sex determination, immunogenetics, genetic counseling. Problem solving, and mastering the methodology of human karyotyping. 3 lecture/problems, 1 three-hour laboratory, 1 or 2 field trips. Prerequisite: BIO 211 and BIO 303. Bryant.

BIO 406 Biological Systematics (3)

Interpretation of biological variability; kinds and origins of organismic variation, the species and speciation, phylogenetic inference, classification and nomenclature. 3 lecture/problems. Prerequisite: BOT 124/124L or 125/125L, ZOO 137/137L or 138/138L, BIO 213; recommended: BIO 303, 325. Clark.

BIO 410 Biophysics (4)

Concepts and mechanisms involved in the interpretation of biological systems. A description of living processes in physical terms. 4 lecture/problems. (See also PHY 410.) Prerequisite: PHY 123 or permission of instructor. Staff.

BIO 415L Field Studies in the Southwest (4)

Ecology and natural history of Southwest habitats; field research projects involving species diversity and community organization. one-week trip to Chiricahua Mts., Arizona. Field trip fee expense required. Lecture, laboratory. Prerequisites: BIO 211, BIO 325/325L. Bryant, Moriarty, Quinn.

BIO 418/418L Population Ecology (2/1)

Factors affecting the abundance and distribution of animal populations in their natural environment. 2 lecture/problems, 1 three-hour laboratory.

Prerequisite: BIO 325/325L. Bryant, Carleton, Moriarty, Szijj.

+BIO 420 Water Pollution Biology (3)

Major pollutants and their effects on aquatic organisms, human health, and use of water resources. 3 lecture/problems. Prerequisite: consent of instructor. Mercer.

BIO 421 Advanced Genetics (3)

Recent advances in genetics with emphasis on gene structure, function, and regulation. 3 lecture/problems. Prerequisite: BIO 303. Bozak, Bryant, Campbell.

+BIO 423/423L Cell Biology (2/2)

General structure and ultrastructure of the cell. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L, ZOO 138/138L. Campbell, Kageyama, Troncale.

BIO 425/425L Chaparral Biology (3/1)

Structure, function, and management of the California chaparral. 3 lecture/problems, 1 three-hour laboratory. Some one-day field trips. Prerequisite: BIO 325. Quinn.

BIO 430/430L Fresh Water Biology (3/2)

Ecology and natural history of major plant and animal groups in various fresh water habitats, and their relationship to fisheries, wildlife management, water, sanitation, and conservation. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 125/125L, ZOO 137/137L or consent of instructor. Mercer.

BIO 431/431L Radiation Biology (3/1)

Introduction to radioisotope tracer techniques, radiometric analyses, effects of ionizing radiation, radiation safety and health physics as applied to life sciences and public health. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: 12 units of Biological Sciences, 8 units of Chemistry, 8 units of Physics. Staff.

BIO 435/435L Cellular Physiology (3/2)

Physiological mechanisms at the cellular level. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: CHM 201 or 314. Kageyama.

BIO 436 History and Philosophy of Biology (4)

Introduction to the historical relationship between natural philosophy and natural science, with special reference to the life sciences, including a consideration of the development of the scientific method in biology; an overview of the growth of biology in relation to the Western scientific revolution, with special emphasis upon the nineteenth century, including a consideration of humanist values in biology. 4 lecture/problems. Firstman.

BIO 441 Internship in Biology (1–2)

On-the-job training in student's area of interest or academic and practical experience in assisting and tutoring in laboratory or field courses. Limited to upper division students in good standing. Written evaluation from job supervisor or instructor required upon completion. Credit for assisting or tutoring limited to a maximum of 3 units to be earned in at least two courses. Total credit for on-the-job training limited to 6 units. Prerequisite: Internship coordinator or laboratory instructor approval of student's application for internship credit (forms available from Biological Sciences Department). Staff.

BIO 442/442L Marine Ecology (3/2)

Structure and function of marine ecosystems with emphasis on littoral environments. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: BIO 325/325L, or consent of instructor. Arnold.

BIO 445/445L Population Genetics (3/1)

Theory and experimental results in population genetics; the interrelation of population genetics and ecological and evolutionary studies. 3 lecture/problems, 1 three-hour laboratory. Possible required field trips. Prerequisites: BIO 211 and BIO 303. Bryant.

BIO 450 Concepts of Molecular Biology (4)

The molecular basis and control mechanisms of biological processes such as information processing, energy processing, assembly of macromolecules into functional units, and evolution of macromolecules. 4 lecture/problems. Prerequisite: Consent of instructor. Bozak, Sperry, Troncale.

BIO 451/451L Molecular Biology Techniques (3/2)

Principles and practice of major techniques used in isolation and characterization of biologically important macromolecules, with primary emphasis on centrifugation, chromatography, and electrophoresis. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: Consent of instructor. Bozak, Sperry, Troncale.

BIO 455/455L Molecular Biology of Recombinant DNA (2/2)

Molecular biology of nucleic acids including isolation, purification and analysis of virus, plasmid, procaryotic and eucaryotic DNA; restriction endonuclease analysis, Southern blotting and molecular hybridization with radioactive probe; concepts on strategies of gene cloning and usefulness of cloned genes. 2 lecture/problems, 2 three-hour laboratories. Prerequisites: BIO 303, MIC 201/201L, and CHM 321 or consent of instructor. Bozak, Pal.

BIO 461, 462 Senior Project (2) (2)

Research conducted under faculty supervision. Written thesis in accordance with professional standards required upon completion of project. Total credit limited to 6 units. Recommended for students in any of the biological sciences majors contemplating graduate or professional school training. Prerequisite: Written consent of student's research advisor prior to enrolling. Staff.

BIO 485 Tropical Biology (3)

A lecture course designed to introduce the physical and biological characteristics of tropical environments, with special emphasis on the ecosystems found in the northern portion of South America. Requirements: advanced senior or graduate standing, and consent of the instructor. Three lecture/discussions. Prerequisites: BIO 325/325L or equivalent. Szijj.

BIO 490 Scientific Communication II (1)

Oral and written presentation of selected topics in biology. Prerequisites: ENG 105 and COM 204, and MAT 120 or MAT 130, and BIO 303. One hour lecture/problem

BIO 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture/problems, laboratory problems, or a combination of both. Staff.

Graduate courses are listed in the graduate section of the catalog.

BOTANY COURSE DESCRIPTIONS

NOTE: For all courses which have both a lecture component and a laboratory component (e.g. BOT 124/124L), both components are corequisites; that is, they must be taken concurrently.

When appropriate, the names of faculty associated with each course are specified; otherwise "Staff" is noted.

BOT 124/124L Plant Structures and Functions (3/2)

Introduction to the relationship between the structures of plants and their functions. Topics also include plant classification, genetics, growth and development, evolution and ecology. Emphasis on flowering plants. 3 lectures, 2 three-hour laboratories. Prerequisite: BIO 115/115L. Bozak, Carleton

BOT 125/125L Plant Morphology (3/2)

Comparative morphology and phylogenetic relationships of plant groups from bacteria to angiosperms. 3 lectures, 2 three-hour laboratories. Prerequisite: BIO 115/115L. Arnold, Clark

BOT 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture/problems, laboratory, or a combination of both. Staff

BOT 307/307L Plants and People (3/1)

Natural history and uses of plants important to people. Open to all majors (not for core electives for Bio Sci majors). 3 lecture/problems plus field activity. Stoner

BOT 316/316L Plant Environments (3/1)

Effects of environmental factors on the growth and distribution of plant materials used in landscaping. Not for core or support credit for majors in the Biological Sciences Department. 3 lecture/problems, 1 three-hour laboratory. Brum

BOT 323/323L General Plant Pathology (2/2)

Principles of the nature, diagnosis, and control of plant diseases caused by bacteria, fungi, nematodes, viruses, and physiological factors. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L or 125/125L. Stoner

BOT 343/343L California Flora (1/2)

Identification of California wildland plants using dichotomous keys. Recognition of common plant families. Overview of the geographic distribution of plants in southern California. 1 lecture, 2 three-hour labs, required field trips. Prerequisites: BIO 115/115L or BIO 110 and BIO 111L. Recommended course: BOT 124/124L. Clark

BOT 403/403L Plant Genetics (3/1)

Principles of plant inheritance and reproduction. Discussion of cytogenetics, population genetics, cytoplasmic inheritance, and gene transfer. Introduction to the methods of plant biotechnology. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: BOT 124/124L, BIO 303. Bozak

BOT 421/421L Plant Ecology (3/1)

A survey of the interactions between plants and the environment. Examination of the classification, development and structure of major vegetation types, plant communities, and ecosystems. Introduction to the effects of climate, soil and animals on plant growth, development, reproduction, and distribution. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: BIO 325/325L. Brum

BOT 422/422L Plant Physiology (3/2)

Life processes of plants; water relations; nutrition and metabolism; growth and development. 3 lecture/problems, 2 three-hour laboratories. Prerequisites: CHM 105 and BOT 124/124L. Staff

BOT 423/423L Plant Nematology (3/1)

Classification, morphology, biology, and control of important plant parasitic nematodes. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: BIO 115/115L. May be Taken on a CR/NC basis. Mercer

BOT 425/425L Mycology (2/2)

Morphology, physiology, culture, pathology, taxonomy, and general biology of Acrasiales, Labyrinthulales, Myxomycetes, Oomycetes, and Zygomycetes. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L or 125/125L or consent of instructor. Stoner

BOT 426/426L Mycology (2/2)

Morphology, physiology, culture, pathology, taxonomy and general biology of Ascomycetes, Deuteromycetes, and Basidiomycetes. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L or 125/125L or consent of instructor. Stoner

BOT 433/433L Phycology (2/2)

Morphology, taxonomy, ecology, and physiology of marine and freshwater algae. Emphasis on local marine habitat. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L, BOT 125/125L. Arnold

BOT 434/434L Evolution of Plants (3/2)

Evolution of plants as illustrated by the comparative morphology, reproductive patterns, and fossil record of green algae, bryophytes, and vascular plants. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L, BOT 125/125L, BIO 213, or consent of instructor. Clark

BOT 435/435L Plant Anatomy (2/2)

Microscopic study of representative common plants dealing with origin, development, and structure of cells, tissues and tissue systems in roots, stems, and leaves. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 124/124L or BOT 125/125L. Clark

BOT 436/436L Plant Taxonomy (2/2)

Principles of classification and nomenclature of plants, with emphasis on the angiosperms. 2 lectures, 2 three-hour labs. Prerequisite: BOT 124/124L or BOT 343/343L. Clark

BOT 440/440L Diagnosis and Control of Plant Diseases (2/2)

Principles and practice in the diagnosis of plant diseases and in the prescription of control measures; cultural remedies, disease management, and integrated controls; field practice; and a review of advances in plant pathology. 2 lecture/problems, 2 three-hour laboratories. Field trips required. Prerequisite: BOT 323/323L. Stoner

BOT 441/441L Methods in Plant Pathology (2/2)

Laboratory and greenhouse methods for isolation, identification, inoculation, and disease assessment for plant pathogenic bacteria, fungi, and viruses which are plant pathogens. Emphasis on screening procedures and other experimental skills. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BOT 323/323L. Stoner

BOT 456/456L Plant Tissue Culture (1/3)

Methods and applications, including: selection and sterilization of explants; preparation and sterilization of media; sterile techniques; incubation of cultures; review of literature. 1 lecture/problem, 2 three-hour labs. Prerequisite: BOT 422. Bozak

BOT 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture/problem, laboratory, or a combination of both.

MICROBIOLOGY COURSE DESCRIPTIONS

NOTE: For all courses which have both a lecture component and a laboratory component (e.g. BIO 115/115L), both components are corequisites; that is, they must be taken concurrently.

When appropriate, the names of faculty associated with each course are specified, otherwise, "Staff" is noted.

MIC 100 World of Microbes (4)

Microorganisms and man's existence. Elements of microbiology and applications to daily life. For nonbiological science majors. 4 lecture/discussions. Chan, Jackson

MIC 201/201L Basic Microbiology (3/2)

A study of morphology, metabolism, classification, and cultivation of bacteria with emphasis on problem solving, identification, and growth of microbes. The role of microbes in disease processes and concepts of immunity and resistance are discussed. 3 lectures, 2 three-hour laboratories. Prerequisite: BIO 110 or 115/115L; CHM 104, 141L or CHM 111, 151L. McKane, Shafia, Staff

MIC 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture/problem, laboratory, or a combination of both. Staff

MIC 300/300L Microbial Structures and Functions (3/2)

Advanced aspects of general microbiology with emphasis upon structure and function of cell components, nutritional types of bacteria, and growth and enumeration of bacteria. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: MIC 201/201L, CHM 201, and 250L or 314, 315 and 317L. Staff

MIC 310/310L Applied Microbiology (3/2)

The microbiology of foods, air, water, and sewage, stressing the utilization of microbial activities in manufacturing processes of foods, types and prevention of food spoilage, aims and methods of water treatment and sewage disposal. 3 lecture/problems. 2 three-hour laboratories. Prerequisite: MIC 201, CHM 201/201L, and 250L or 314, 315, and 317L. Staff

MIC 320/320L Food Microbiology (2/2)

The microbiology of foods as related to storage, transit, human consumption, and health. For foods and nutrition majors. 2 lecture/problems, 2 three-hour laboratories. Prerequisites: MIC 201/201L, CHM 201 and 250L. Staff

MIC 330 General Epidemiology (4)

Fundamental concepts in the study of disease occurrence in human populations. Emphasis on descriptive epidemiology, formulation of hypotheses, and analytic epidemiology, and case studies with problem solving. 4 lecture/problems. Prerequisites: MIC 201, BIO 211. Chan

MIC 410/410L Medical Bacteriology (3/2)

Characteristics of disease-producing bacteria, their means of transmission, host-parasite interactions, and laboratory methods of diagnosis. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: MIC 300/300L. Jackson

MIC 415/415L Immunology-Serology (3/2)

Principles of serology and immunology with emphasis on mechanisms of evaluating resistance to pathogens, and on mechanism of response to antigens on the molecular and cellular level. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: MIC 300/300L. Adler

MIC 422/422L Clinical Laboratory Procedures (2/2)

Principles and methods in clinical analysis and evaluation of fluids, cells, tissues, and other body components, waste products, or derivatives. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: CHM 328, ZOO 235/235L. Staff

MIC 425/425L Medical Mycology (3/2)

Characteristics, habitats and laboratory identification of fungi inciting human and animal diseases. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: MIC 201/201L. Adler

MIC 430/430L General Virology (3/2)

Chemical composition and physical structure of viruses; their mechanism of reproduction; relationship to man, animals, and plants. Introduction to diagnostic techniques used in the isolation and identification of viruses. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: MIC 300/300L. Pal

MIC 444/444L Hematology (3/1)

The anatomy, physiology, and pathology of the normal hematopoietic system; frequently encountered blood dyscrasias related to human red blood cells. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ZOO 138/138L or permission of instruction. Chan.

MIC 445/445L Immunohematology (3/1)

General characteristics of human blood group antigens; antigen-antibody reactions related to human red blood cells and human diseases. 3 lecture/problems and one three-hour laboratory. Prerequisite: MIC 415/415L or permission of instructor. Chan.

MIC 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture/problems, laboratory, or a combination of both. Staff

ZOOLOGY COURSE DESCRIPTIONS

For all courses which have both a lecture component and a laboratory component (e.g. ZOO 137/137L), both components are co-requisites, that is, they must be taken concurrently.

When appropriate, the names of faculty associated with each course are specified; otherwise, "Staff" is noted.

ZOO 112/112L The World of Animals (3/1)

Characteristics, reproduction, behavior, ecology, and interactions with mankind of the major groups of invertebrate and vertebrate animals. 3 lectures, 1 two-hour activity. Staff

ZOO 137/137L Invertebrate Zoology (3/2)

Evolution and general biology of major phyla of invertebrate animals, Protozoa to Chordata; introduction to the structure and function of invertebrate organ systems. 3 lectures, 2 three-hour laboratories. Prerequisite: BIO 115/115L. Staff

ZOO 138/138L Vertebrate Zoology (3/2)

Evolution and general biology of animals within the phylum Chordata; introduction to the structure and function of vertebrate organ systems, 3 lectures, 2 three-hour laboratories. Prerequisite: BIO 115/115L. Hoyt

ZOO 234/234L Human Anatomy (2/2)

Lectures devoted to a description of human gross anatomy. Laboratories emphasize systematic anatomy and use preserved human organs and dissected cadavers on demonstration. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: BIO 115/115L. Bath

ZOO 235/235L Human Physiology (3/1)

Functions of the major organ systems of the human body with emphasis on the homeostatic mechanisms. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: BIO 115/115L. Steele

ZOO 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture/problems, laboratory, or a combination of both. Staff

ZOO 329/329L Ornithology (2/1)

The evolution, anatomy and physiology of birds with special emphasis on behavior and ecological relationships of species of the Pacific Coast. 2 lecture/problems, 1 three-hour laboratory, or field exercises, or projects. Two weekend field trips are required for credit in this course. Prerequisite: ZOO 138/138L or consent of instructor. Moriarty, Szijj

ZOO 411/411L Biology of Spiders (1/2)

Recognition of the local spider families, and study of general spider biology, including basic morphology, behavior, ecology, ontogeny, evolution and higher systematics. 1 lecture/problem, 2 three-hour laboratories. Prerequisite: ZOO 137/137L or consent of instructor. Firstman

ZOO 414/414L Embryology (2/3)

Embryonic development of the vertebrate body. 2 lecture/problems, 3 three-hour laboratories. Prerequisite: ZOO 138/138L. Firstman

ZOO 415/ZOO 415L Human Embryology (4)

Descriptive human developmental anatomy, including general embryogeny through fetal period, the origins of the major organ systems, and sense organs. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ZOO 138 or equivalent. Firstman

ZOO 419/419L Animal Behavior (2/1)

Biological, physiological, genetic and anatomical principles of animal behavior. Ethology and experimental psychology involving wild and laboratory animals. 2 lecture/problems, 1 three-hour laboratory. Prerequisite: ZOO 138/138L or consent of instructor. Szijj

ZOO 422/422L Histology (2/3)

Microscopic study of vertebrate tissues; organology and correlation of form with function. 2 lecture/problems, 3 three-hour laboratories, taught in the audio-tutorial mode. Prerequisite: ZOO 138/138L. Staff

ZOO 424/424L Comparative Animal Physiology (3/2)

Introduction to functions of vertebrate and invertebrate organ systems. 3 lecture/problems, 2 three-hour laboratories. Prerequisites: ZOO 138/138L, CHM 106. Stiffler, Hoyt

ZOO 425/425L Medical Parasitology (3/2)

Study of protozoan and helminth parasites of man: diagnosis, life cycles, pathology, epidemiology and control. 3 lecture/problems, 2 three-hour laboratories. Prerequisite: ZOO 137/137L. Castro

ZOO 426/426L Introduction to Entomology (3/1)

General aspects of insect structure and function, development, behavior and influence on human activity; includes a survey of the principal insect groups. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: BIO 115/115L, ZOO 137/137L or consent of instructor. Edmonds, George

ZOO 429/429L Herpetology (2/2)

Morphology, classification, distribution, ecology, behavior and conservation of amphibians and reptiles; identification, and field study of local species. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: ZOO 138/138L or equivalent. Stewart

ZOO 430/430L Mammalogy (2/2)

Morphology, classification, distribution, ecology, behavior and conservation of mammals; identification, and field study of local species. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: ZOO 138/138L or equivalent. Stewart

ZOO 435/435L Public Health Entomology (3/1)

Role of insects, mites, ticks and other arthropods in the causation and transmission of human disease. 3 lecture/problems, 1 three-hour laboratory. Staff

ZOO 437 Evolution of the Vertebrates (4)

A survey of vertebrate adaptive radiation since the first appearance of the subphylum Vertebrata in the late Cambrian, including a study of the fossil evidence, and the macroevolutionary novelties which permitted the success of the various vertebrate clades. 4 lectures. Prerequisite: ZOO 138/138L. Firstman.

ZOO 438/438L Evolution of the Invertebrates (4)

A systematic survey of all invertebrate groups including the minor phyla, with emphasis upon comparative morphology and phylogeny, including also comparative developmental and physiological evidence of evolutionary relationships between the higher taxa. 4 lecture/problems. Prerequisite: ZOO 137/137L or equivalent. Firstman

ZOO 440/440L Physiological Ecology of Animals (3/1)

A combined lecture and group discussion of the physiological and behavioral adaptions of animals to their environment. Emphasis on energetics, thermoregulation, and the evolution of endothermy and homeothermy in terrestrial vertebrates. Additional topics selected by students. Lab consists of an independent research project. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: ZOO 424/424L or consent of instructor. Hoyt.

ZOO 441/441L Ichthyology (2/2)

The structure, relationships, classification, general biology and zoogeography of fishes. Collection identification and field study of local species, and laboratory work with preserved and living material. 2 lecture/problems and 2 three-hour laboratories. Prerequisite: ZOO 138/138L and consent of instructor. Baskin

ZOO 451/451L Comparative Anatomy of Vertebrates (3/2)

A phylogenetic analysis of the vertebrates based on the structure of organ systems. Includes discussion of the principles of comparative biology, and the significance of comparative morphological data for understanding vertebrate history. 3 lecture/problems. 2 three-hour laboratories. Prerequisite: ZOO 138/138L. Baskin

ZOO 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: consent of instructor. Instruction is by lecture/problems, laboratory, or a combination of both. Staff

CHEMISTRY

Keith Howard, *Chair*

Victor P. Abegg	Phillip Beauchamp
Fredrick Bet-Pera	Charles Bowen
Ruth J. Bowen	David Brown
Barbara Burke	Joe Casalnuovo
Vasu Dev	Francis Flores
Elisheva Goldstein	George Gutnikov
David A. Haner	Paul C. Hiemenz
Yu-Ping Hsia	Michael L. Keith
Mary Zi-ping Luo	Walter Maya
Charles Millner	Patrick Wm. Mobley
Nelson Scott	J. Ernest Simpson
Edward D. Walton	

The Chemistry Department offers a flexible program of studies designed to prepare students for careers in private industry and government or for highly diverse graduate study. Students may direct their efforts into all the major areas of chemistry and into certain interdisciplinary areas. This is accomplished by choosing one of three rigorous tracks or options of study leading to the Bachelor of Science degree in Chemistry.

The "chemistry" option emphasizes the chemistry-physics interface. The curriculum of this option leads to the more traditional careers and graduate training in chemistry.

The "chemical sciences" option stresses the growing body of knowledge at the chemistry-life sciences interface. Beyond the core curriculum students may pursue programs in the chemistry of plants, animals or human beings (biochemistry, clinical chemistry, marine biochemistry, pre-medicine, pre-dentistry, etc.). Upon consultation with a departmental advisor, the student may select courses from a list of restricted electives thereby achieving a program meeting that individual's career goals.

The "industrial chemistry" option is designed for those students who plan a career in the chemical industries and businesses. Option courses have been chosen to provide some background in material sciences as well as industrial chemistry. Restricted elective packages create a flexible program which will meet a variety of career goals.

The baccalaureate degree in chemistry earned by following any of the options may be certified by the American Chemical Society as having met its standards for professionalism at the undergraduate level, provided that a suitable pattern of electives is chosen. Students should consult with departmental advisors to determine which courses are required in their option for certification.

Chemistry majors following either the Chemistry or Chemical Sciences Option are reminded that up to 16 units of credit can be earned for approved work experience under the heading of Cooperative Education. This work experience is an integral part of the Industrial Chemistry Option. Additional details will be found listed at the beginning of the College of Science section of this catalog.

The department also offers a minor in chemistry to students from other majors. This should be of special interest to non-chemistry majors whose curriculum already involves substantial chemistry requirements, such as chemical engineering, microbiology and pre-professional majors.

For those planning a career as a secondary school science teacher, a single subject credential in Science is required. This credential is obtained by completing coursework in Education and passing the National Teacher Examination. The latter can be waived by taking the courses listed in the Waiver Program. See the Director of the Centers for Education & Equity in Mathematics, Science and technology for additional information.

Students interested in becoming members of the American Chemical Society may join the Student Affiliates of the American Chemical Society. Additional information can be obtained from the Chemistry Department.

ONE YEAR MASTER OF SCIENCE PROGRAM: The department offers a Master's degree which can be completed in five years of combined undergraduate and graduate study. Should a student decide to pursue this program a decision should be made in the beginning of the junior year so that a departmental petition may be initiated. The petition will outline the tentative program for the 4th and 5th years and should be planned together with completion of appropriate petitions to the Office of Graduate Studies. Interested students should contact the department's graduate advisor.

Two notable features are associated with the program. 1) Students will be eligible to take selected graduate courses in their senior year and 2) the senior project which is required of all Chemistry majors can be extended into an appropriate research problem which would be the subject of the student's master's thesis.

CORE COURSES FOR MAJOR*

(Required of all students)

General Chemistry	CHM 111/151L	(3/1)
General Chemistry	CHM 112/152L	(3/1)
General Chemistry	CHM 113/153L	(3/1)
Quantitative Analysis	CHM 221/221L	(2/2)
Organic Chemistry	CHM 314	(3)
Organic Chemistry	CHM 315	(3)
Organic Chemistry	CHM 316	(3)
Organic Chemistry Lab	CHM 317L	(1)
Organic Chemistry Lab	CHM 318L	(1)
Organic Chemistry Lab	CHM 319L	(1)
Spectroscopic Methods	CHM 342/342L	(2/2)
Separation Methods	CHM 343/343L	(2/2)
Electroanalytical Methods	CHM 344/344L	(2/2)
Physical Chemistry Lab	CHM 352L	(3)
Organic Analysis	CHM 424/424L	(2/2)
Senior Research Project	CHM 491	(3)
Senior Research Project	CHM 492	(3)
Undergraduate Seminar	CHM 493	(2)
Advanced Chemistry Electives		(6)

(Two elective courses, approved 300, 400-level or higher excluding CHM 400, 491, 492, 493, 499. For the Industrial Chemistry Option only, choose from the following: CHM 402, 409, 413, 422/422L, 442, 442L, 446/446L, 450, 452, 452L, 460.)

OPTION COURSES FOR MAJOR*

(Required for specific options)

CHEMISTRY

Physical Chemistry	CHM 311	(3)
Physical Chemistry	CHM 312	(3)
Physical Chemistry	CHM 313	(3)
Physical Chemistry Lab	CHM 353L	(2)
Inorganic Chemistry	CHM 401	(3)
Inorganic Chemistry	CHM 402	(3)

CHEMICAL SCIENCES

Elements of Physical Chemistry	CHM 304/304A	(3/1)
Elements of Physical Chemistry	CHM 305	(3)
Biochemistry	CHM 327/327L	(3/1)
Biochemistry	CHM 328/328L	(3/1)
Biochemistry	CHM 329/329L	(3/1)

INDUSTRIAL CHEMISTRY

Elements of Physical Chemistry	CHM 304/304A	(3/1)
and Elements of Physical Chemistry	CHM 305	(3)
or Physical Chemistry	CHM 311	(3)

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* A 2.0 cumulative GPA is required in core courses including option courses for the major in order to receive a degree in the major.

and Physical Chemistry	CHM	312	(3)
and Physical Chemistry	CHM	313	(3)
Chemistry in Industry	CHM	340	(4)
Elem of Biochemistry	CHM	321/321L	(3/1)
or Biochemistry	CHM	327/327L	(3/1)
or Inorganic Chemistry	CHM	401	(3)

SUPPORT AND ELECTIVE COURSES

(Required of all students)

Pascal	CS	120	(4)
or FORTRAN	CS	125	(4)
Calculus & Analytic Geometry	MAT	115	(4)
Calculus & Analytic Geometry	MAT	116	(4)
General Physics	PHY	132/152L	(3/1)
General Physics	PHY	133/153L	(3/1)

CHEMISTRY OPTION

Elem Statistics with Applications	STA	120	(4)
Differential Equations	MAT	216	(4)
Electives, unrestricted			(23-25)

CHEMICAL SCIENCES OPTION

Elem Statistics with Applications	STA	120	(4)
*Electives, restricted			(14-20)
Electives, unrestricted			(19-25)

INDUSTRIAL CHEMISTRY OPTION

FORTRAN	CS	125	(4)
Statistical Methods in Engineering and Physical Science	STA	309	(3)
Mtrl. Sci. and Eng.	MTE	207	(3)
Mrtl. Sci. and Eng. Lab.	MTE	217	(1)
** Co-op Ed.	SCI	470	(4)
or Co-op Ed.	SCI	471	(2)
and Co-op Ed.	SCI	472	(2)
* Electives, restricted			(42-49)
Electives, unrestricted			(2-9)

*Consult the Chemistry Department for details and restrictions.

** If a suitable Co-op position is not available an additional advanced chemistry elective should be taken.

GENERAL EDUCATION COURSES

Area 1:

A. Freshman English I	ENG	104	(4)
B. and C. Consult the catalog			(8)

Area 2:

A. Calculus & Analytic Geom	MAT	114	(4)
B. General Physics	PHY	131/151L	(3/1)
C. Basic Biology	BIO	115/115L	(3/2)
D. Select one course			(4)

Area 3:

A. Select one course			(4)
B. Select one course			(4)
C. Select one course			(4)

A reading knowledge of a foreign language, especially German, is strongly recommended for students planning advanced study in science.

D. For industrial Chemistry option:			
Principles of Economics	EC	201	(4)
For other options: See approved List			(4)
E. Select one course			(4)
F. Select one course			(4)
G. For Industrial Chemistry Option:			
General Psychology	PSY	201	(4)
For other options: See approved list			(4)

Area 4:

United States History	HST	202	(4)
Intro to American Government	PLS	201	(4)

Area 5:

Upper division. Minimum	(8)

Consult the Chemistry Department or an advisor about the specific groups of courses allowed in this area.

CHEMISTRY MINOR

Minimum units 29
Minimum upper-division units 12

College Chemistry	CHM	104/141L	(3/1)
or General Chemistry	CHM	111/151L	(3/1)
College Chemistry	CHM	105/142L	(3/1)
or General Chemistry	CHM	112/152L	(3/1)
College Chemistry	CHM	106/143L	(3/1)
or General Chemistry	CHM	113/153L	(3/1)
Organic Chemistry Elements	CHM	201/250L	(3/1)
or Organic Chemistry	CHM	314/317L	(3/1)
Quantitative Analysis	CHM	221/221L	(2/2)
Physical Chemistry Fundamentals	CHM	301/301A	(3/1)
or			
Elements of Physical Chemistry	CHM	304/304A	(3/1)
or Physical Chemistry	CHM	311	(3)
Chemistry Electives			(5)

(Two courses 300-level or higher excluding CHM 400, 491, 492, 493, 499.)

Course Descriptions

The notations F, W, Sp, Su, and even or odd indicate which quarter(s) of even or odd numbered calendar years the course is normally offered. Courses not designated "even" or "odd" are offered each year.

CHM 101/101A Consumer Chemistry (3/1)

Introduction to atoms, molecules and bondings. Petrochemicals, plastics and fibers. Air and water pollution. Body chemistry, foods, drugs and poisons. Chemical and nuclear energy. Not open to students who have credit for CHM 103, 104 or 111. 3 lectures, 1 recitation. Concurrent enrollment required.

CHM 103/103A Fundamentals of Chemistry (3/1) FWSp

Atoms, molecules and physical states of matter. Important classes of chemical compounds and chemical reactions. Experimentation as the approach to solving problems of natural phenomena. Not open to students who have credit for CHM 104 or 111. 3 lectures, 1 recitation. Concurrent enrollment required.

CHM 104, 105, 106 College Chemistry (3) (3) (3) FWSpSu

Principles of atomic structure, periodicity, stoichiometry, gases, solutions, acids and bases, equilibrium, oxidation-reduction, electrochemistry, thermodynamics and their applications to the life sciences and agricultural sciences. 3 lecture/problems. To be taken in sequence. For majors not requiring calculus. Prerequisite to CHM 104: high school chemistry or CHM 103 and high school algebra. Concurrent: CHM 141L, 142L, 143L, respectively.

CHM 111, 112, 113 General Chemistry (3) (3) (3) FWSpSu

Atomic theory of structure and bonding, chemical equations, gas laws, oxidation-reduction, electrochemistry, states of matter, equilibrium, acids and bases, thermodynamics and reaction kinetics and their applications to chemistry, physics, and engineering sciences. For majors requiring calculus. 3 lecture/problems. To be taken in sequence. Prerequisite to CHM 111: high school chemistry or CHM 103 and high school algebra. Concurrent: CHM 151L, 152L, 153L, respectively.

CHM 141L, 142L, 143L College Chemistry Laboratory (1) (1) (1) FWSpSu

Laboratory to accompany College Chemistry lecture series. Experiments in stoichiometry, acid-base, Ph and redox titrations, simple quantitative analysis, gas measurements, ionic equilibria, and qualitative analysis. 1 three-hour laboratory. To be taken in sequence concurrently with CHM 104, 105, 106, respectively.

CHM 151L, 152L, 153L General Chemistry Laboratory (1) (1) (1) FWSpSu

Laboratory to accompany General Chemistry lecture series. Experiments in basic quantitative analysis techniques, gas measurements, acid-base, pH, and redox titrations, electrochemistry, kinetics, thermo-dynamics, and ionic equilibria and qualitative analysis procedures. 1 three-hour laboratory. To be taken in sequence concurrently with CHM 111, 112, 113, respectively.

CHM 200 Special Problems for Lower Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CHM 201 Elements of Organic Chemistry (3) FWSpSu

The fundamental concepts of organic chemistry with emphasis on practical applications. For students who are required to take one quarter of organic chemistry. Not open for credit to chemistry majors. 3 lecture/problems. Prerequisite: CHM 105 or 112. Concurrent: CHM 250L.

CHM 210 Chemistry in Life, Civilization and the World (4) FWSp

A study of the impact of chemistry on life, civilization, and the world. How applications of chemical knowledge, science and technology affect the human experience. Chemistry as a central science of technology. Benefits and risks of science and technology. 4 lecture/problems. Prerequisites: One course each in G.E. Categories IIA, IIB and IIC.

CHM 221/221L Quantitative Analysis (2/2) FWSpSu

Fundamentals of gravimetric and volumetric analysis. Focus on laboratory work, with class discussion supplying supporting theory. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: CHM 106 or 113. Students are advised to take 221/221L as soon as possible after completing either 106 or 113. Concurrent enrollment required.

CHM 250L Elements of Organic Chemistry Laboratory (1) FWSpSu

Introduction to general techniques of the organic laboratory for the separation, purification and identification of organic substances. Survey of the laboratory preparation and reactions of different functional groups with emphasis on the practical application. 1 three-hour laboratory. Not open for credit to chemistry majors. Prerequisite: CHM 105 or 112. Concurrent: CHM 201.

CHM 256L Glassblowing (1) Sp

Fundamental techniques of laboratory glassblowing. A practical course to teach students to construct and repair special pieces of glass apparatus used in advanced chemistry courses and senior project work. 1 three-hour laboratory, scheduled by arrangement.

CHM 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture, laboratory or a combination of both.

CHM 301/301A Fundamentals of Physical Chemistry (3/1) FSp

Thermodynamic properties of chemical species and their application; kinetics, measurements of physical properties of molecules. Not open to students whose majors require CHM 304 or CHM 311. 3 lecture/problems, 1 recitation. Prerequisite: CHM 106 or 113.

CHM 304/304A, 305 Elements of Physical Chemistry (3/1) (3) FW

A two-quarter sequence of physical chemistry covering properties of gases, chemical thermodynamics, solutions, electrochemistry, reaction kinetics, and atomic and molecular structure. To be taken in sequence. 3 lecture/problems, 1 recitation for 304, 3 lecture/problems for 305. Prerequisite: MAT 116, CHM 113, PHY 133, or their equivalents. Concurrent with CHM 305: CHM 352L.

CHM 306 History and Philosophy of Chemistry (4) W

The history of chemistry from antiquity to the present, with special emphasis on the scientific revolution. Four one-hour lectures per week. No prerequisites except Junior standing.

CHM 311, 312, 313 Physical Chemistry (3) (3) (3) FSu, WSu, SpF

Properties of gases, kinetic molecular theory, chemical thermodynamics, phase equilibria, solutions, electrochemistry, chemical kinetics, atomic and molecular spectroscopy, photochemistry, colloids and macromolecules. To be taken in sequence. 3 lecture/problems. Prerequisite: MAT 216 or equivalent, CHM 106 or 113 and one year of college physics.

CHM 314, 315, 316 Organic Chemistry (3)(3)(3) FWSpSu

Modern concepts of chemical bonding, molecular structure, principles of stereochemistry and conformation, reaction mechanisms and synthetic pathways. All common classes and substituents of organic compounds treated. Carbohydrates, heterocyclics and other biologically significant compounds may be introduced. To be taken in sequence. 3 lecture/problems. Prerequisite: CHM 106 or 113. Concurrent: CHM 317L, 318L, 319L, respectively for Chemistry majors.

CHM 317L Organic Chemistry Laboratory (1) FWSpSu

Introduction to general techniques of the organic laboratory for the separation, purification and identification of organic substances. Interpretation of IR spectra of organic compounds. 1 three-hour laboratory. Prerequisite: CHM 106 or 113. Concurrent: CHM 314.

CHM 318L Organic Chemistry Laboratory (1) FWSpSu

Application of reaction mechanisms toward the synthesis of organic molecules. Interpretation of IR and NMR spectra of organic molecules. 1 three-hour laboratory. Prerequisite: CHM 317L. Concurrent: CHM 315.

CHM 319L Organic Chemistry Laboratory (1) FWSpSu

Multistep syntheses. Extensive interpretation of IR and NMR spectra of organic compounds. 1 three-hour laboratory. Prerequisite: CHM 318L. Concurrent: CHM 316.

CHM 321/321L Elements of Biochemistry (3/1) FWSpSu

The fundamental concepts of biochemistry with emphasis on structure-function relationships as they relate to carbohydrates, lipids, proteins, and nucleic acids. Designed for students who are required to take one quarter of biochemistry. Not open for credit to Chemistry majors. 3 lecture/problems, 1 three-hour laboratory. Concurrent enrollment required. Prerequisite: CHM 201 and 250L, or CHM 315 and 318L.

CHM 327 Biochemistry (3) FW

Chemistry of carbohydrates, lipids, proteins and enzymes. Enzyme reactions and kinetics; glycolysis and the citric acid cycle metabolism. Corequisite: CHM 327L. Prerequisite: CHM 315 and 317.

CHM 327L Biochemistry Laboratory (1) FW

Laboratory work includes the study of pH and buffers, carbohydrates, lipids, proteins and enzyme kinetics. Qualitative and quantitative methods employing instrumental analysis are included. Corequisite: CHM 327.

CHM 328 Biochemistry (3) WSp

Chemistry of vitamins, trace metals and important agents in metabolic control; glyoxalate cycle, pentose phosphate pathway, electron transport, cellular control, photosynthesis and nucleic acid structures. Nutritional chemistry, as it relates to vitamin function, is also covered. Corequisite: CHM 328L. Prerequisite: CHM 327, 327L.

CHM 328L Biochemistry Laboratory (1) WSp

Standard curve for protein analysis as well as spectrophotometric quantitation, isolation and partial purification of biomolecules using centrifugation, liquid column chromatography, salts, heat treatment and electrophoresis. Laboratory work includes study of tissue extracts and other instrumental methods in biochemistry. Corequisite: CHM 328.

CHM 329 Biochemistry (3) SpSu

Metabolism of lipids and nucleic acids, biochemistry of DNA replication, RNA transcription, protein translation and membrane dynamics. Corequisite: CHM 329L. Prerequisite: CHM 328, 328L.

CHM 329L Biochemistry Laboratory (1) SpSu

Purification and analysis of membranes, analysis of protein ligand interactions, extraction and denaturation of DNA. Laboratory work includes denaturing electrophoresis, spectrophotometry and other instrumental methods in biochemistry. Corequisite: CHM 329.

CHM 331/331L Clinical Chemistry (2/2) WSp

Introduction to the principles and procedures used in the clinical laboratory for the analysis of blood and urine specimens. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: CHM 221/221L and 327/327L or 321/321L. Concurrent enrollment required.

CHM 340 The Chemist in Industry (4) FSp

Survey of roles and expectations for chemists in industry and applications of chemical reactions and principles in the petroleum, biotechnology, pharmaceuticals, food, inorganics, polymers, aerospace, coatings and metal industries. Interfaces with economics, patents, chemical engineering and communication. Guest speakers and plant visits. 4 lecture/problems. Prerequisite: CHM 106 or 113 and 201 or 314.

CHM 342/342L Spectroscopic Methods (2/2) (F)

Theory and practice of modern analytical techniques based primarily on optical spectroscopy such as UV, IR, AAS, AFS, AES and fluorescence. 2 lecture/problems, 2 three-hour laboratories. Involves some inorganic synthesis. Prerequisite: CHM 221/221L. Concurrent enrollment required.

CHM 343/343L Separation Methods (2/2) (W)

Theory and practice of modern analytical separation methods primarily encompassing various chromatographic techniques. 2 lecture/problems, 2 three-hour laboratories. Involves some inorganic synthesis. Prerequisite: CHM 221/221L. Concurrent enrollment required.

CHM 344/344L Electroanalytical Methods (2/2) (Sp)

Theory and practice of modern analytical electrochemistry, with particular emphasis on potentiometry, voltammetry, amperometry, coulometry, chronopotentiometry and cyclic and pulse methods. 2 lecture/problems, 2 three-hour laboratories. Involves some inorganic synthesis. Prerequisite: CHM 221/221L.

CHM 347/347L Theory of Chemical Instrumentation (1/1) Sp

Theory of chemical instrument systems with emphasis on the selection of instrumentation appropriate to a measurement or control problem. 1 lecture/problem, 1 three-hour laboratory. Prerequisite: CHM 344/344L.

CHM 352/352L Physical Chemistry Laboratory (1/2) W

Laboratory experiments illustrating principles of physical chemistry. 1 recitation/problem session and 2 three-hour laboratories. Prerequisite: CHM 221/221L; CHM 304 or 311. Concurrent: CHM 305 or 312.

CHM 353L Physical Chemistry Laboratory (2) Sp

Advanced laboratory applications of physical chemistry. 2 three-hour laboratories. Prerequisite: CHM 352L. Concurrent: CHM 313.

CHM 400 Special Problems for Upper Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CHM 401, 402 Inorganic Chemistry (3) (3) FW

Modern concepts of inorganic chemistry including chemical bonding, acid/base, coordination chemistry, kinetics, organo-metallics and catalysis. To be taken in sequence. 3 lecture/problems. Prerequisite: CHM 313 or 305.

CHM 409 Polymer Chemistry (3) Sp, odd years

Types of polymers and polymerization reactions; properties of polymer solutions and the determination of molecular weights; elasticity and other bulk properties. 3 lecture/problems. Prerequisite: CHM 316 and 305 or 313.

CHM 411 Reaction Kinetics (3) W

Kinetics and mechanisms of chemical reactions. Transition state theory, collision theory, photochemical excitation and dissociation, homogeneous and heterogeneous catalysis. Analysis and solution of problems. 3 lecture/problems. Prerequisite: CHM 305 or 313.

CHM 413 Introduction to Colloid and Surface Chemistry (3) Sp, even years

Gas-liquid, gas-solid and solid-liquid interfaces. Adsorption and surface area determination. The electrical double layer and its relation to flocculation and electrokinetic phenomena. 3 lecture/problems. Prerequisite: CHM 305 or 313.

CHM 415 Chemical Thermodynamics (3) F

Fundamental aspects of chemical thermodynamics, including the first, secon, and third laws. Studies of chemical and phase equilibria, enthalpy, entropy, work and free energy. Relationship to molecular structure and statistical mechanics. 3 lecture/problems. Prerequisite: CHM 305 or 313.

CHM 419 Introduction to Quantum Chemistry (3) F, even years

Mathematical preliminaries, postulates of quantum chemistry, wave functions for some simple chemical models, the central force problem, the Aufbau principle, hybrid orbitals, approximation methods and Hund's multiplicity rule. 3 lecture/problems. Prerequisite: CHM 305 or 313.

CHM 420 Computational Chemistry (4) Sp, odd years

Applied quantum mechanical studies of molecular geometries, electronic excited states, potential energy surfaces and conformational structures spanning from small diatomic species to large biochemical molecules. Spectroscopic problems emphasized. Molecular graphics used to aid in both ab initio and molecular mechanics. Prerequisite: CHM 313, MAT 216. 4 lecture/problems.

CHM 421 Solution Equilibria in Analytical Chemistry (2) F

Study of advanced acid-base theory, complexation, nonaqueous acid-base, solvent extraction and ion-exchange equilibria. 2 lectures. Prerequisite: CHM 313 or 305.

CHM 422/422L Organic Synthesis (2/2) W, even years

Theoretical and practical study of synthetic strategies in organic chemistry. 2 lecture/problems, 2 three-hour laboratories. Prerequisites: CHM 221/221L, 316 and 319L. Concurrent enrollment required.

CHM 423/423L Physical Organic Chemistry (2/2) W, odd years

Theoretical and practical study of experimental techniques used by organic chemists to investigate problems in reaction mechanisms, catalysis, solution chemistry and substituent effects. 2 lecture/problems, 2 three-hour laboratories. Prerequisites: CHM 221/221L, 316 and 319L and 313 or 305.

CHM 424/424L Organic Analysis (2/2) FSp

Structure determination of organic compounds by elemental and functional group analysis using classical methods and modern chromatographic and spectroscopic methods. 2 lectures, 2 three-hour laboratories. Prerequisites: CHM 221/221L, 316 and 319L. Concurrent enrollment required.

CHM 446/446L Corrosion Chemistry (3/1) W

The basic principles of theoretical and applied electrochemistry as it pertains to corrosion. Thermodynamics and kinetics of oxidation. Aqueous corrosion, stress corrosion, hydrogen cracking, fatigue. Corrosion testing, inhibition and design. Cathodic and anodic protection, metal and chemical coatings. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CHM 305 or 313 or consent of instructor.

CHM 448/448L Modern FT-NMR (3/1) F

Fundamentals of one- and two-dimensional NMR and basic understanding of the pulse sequences for a variety of NMR experiments (proton, C-13, SPT, INEPT, DEPT, COSY, HETCOR and NOE). Interpretation of such spectra to determine organic structures. Experience on FT-NMR instrument in weekly sessions to be arranged with instructor. Prerequisites: CHM 316, 319 and CHM 305 or 313, or consent of instructor.

CHM 450 Bioanalytical Chemistry (4) Sp, odd years

Application of instrumental analytical techniques to problems in biotechnology and clinical medicine. Uniqueness of problems inherent in analysis of biological samples and the application of state-of-the-art separation and assay techniques. Prerequisites: CHM 221/221L and CHM 327/327L or CHM 221/221L and CHM 321/321L with consent of instructor. 4 lecture/problems.

CHM 451/451L Enzymology (3/1) F, even years

The nature of enzymes including enzyme kinetics, mechanisms of enzyme-catalyzed reactions, enzyme inhibitors, classification of enzymes. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: CHM 329/329L or consent of instructor. Concurrent enrollment required.

CHM 452/452L Biochemical Preparations (1/2) W, even years

Isolation of some eight different materials from plant and animal sources, such as a blood protein fraction, a plant nucleic acid, a plant terpene, a hormone preparation, a metabolic intermediate and a urinary excretion product. 1 lecture/problem, 2 three-hour laboratories. Prerequisite: CHM 329/329L or consent of instructor. Concurrent enrollment required.

CHM 453 Recombinant DNA Biochemistry (3) Sp

Fundamental aspects of the biochemistry of Recombinant DNA and its applications to current biochemical research and industry. Includes germane aspects of the chemistry, structure and biochemistry of RNA and DNA macromolecules. 3 lecture/problems. Prerequisite: CHM 329/329L or taken concurrently.

CHM 454 Nutrient Biochemistry and Metabolism (3) W, odd years

An advanced course covering the biochemistry of vitamins, minerals, carbohydrates, lipids and proteins. For example: absorption, transport metabolism and storage of these important biochemicals. 3 lecture/problems. Prerequisite: CHM 329/329L or consent of instructor.

CHM 460 Air Pollution Problems (3) W

Concepts of air pollution: major air pollutants; sources; future problems. 3 lecture/problems. Prerequisite: Senior standing or consent of instructor.

CHM 491, 492 Senior Research Project (3) (3) FWSpSu

Senior level research or project. Individual consultation and supervision. Independent literature review, project design, data collection and interpretation of results. Formal report. Prerequisite: Minimum GPA of 2.0 in major.

CHM 493 Undergraduate Seminar (2) FWSp

A study of current developments in chemistry and a discussion of periodical literature at an appropriate level. 2 lecture/discussions. Prerequisites: All required 300-level chemistry courses.

CHM 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of Instructor. Instruction is by lecture, laboratory or a combination of both.

Graduate courses are listed in the graduate section of the catalog.

COMPUTER SCIENCE

Barry I. Soroka, *Chair*

John R. Fisher	Bruce P. Hillam
Peter A. Laszlo	Chung Lee
Debra A. Lelewer	Hsun K. Liu
Hsi-Chiu Liu	Craig Rich
Halina Przymusinska	Daisy F. Sang
H. Norton Riley	Mandayam Srinivas
Barry I. Soroka	
Lan Yang	

The Computer Science program blends practice and theory in both hardware and software, and it provides an excellent foundation in computer languages, computer architecture, large-scale system software and the design, analysis, and application of many types of algorithms.

Success in mathematics is a good indicator for success in the Computer Science program. High school students planning to major in Computer Science should take as much math and science as possible. Entering fresh-persons who do not meet the prerequisites for the first year calculus sequence (Mat 114-116) should expect to take between one and three quarters longer to graduate. Transfer students should try to take two years of calculus, a year of physics and programming through data structures (equivalent to CS 140, 141, 240, 241). Transfer students without this background should expect to take an additional year to finish the program.

On campus students wishing to change their major to Computer Science should first pass both Mat 114 and CS 140 with a grade of C or better before petitioning for change of major. Computer Science majors on probation or subject to disqualification for three or more quarters may be disqualified at the discretion of the department chair.

The department also offers a graduate program leading to the M.S. degree. Details are given in the Graduate Studies section of the catalog.

Membership is open to CS majors in the Bits and Chips Computer Club and local chapters of ACM and IEEE and they may also be invited to join UPE, the national honor society in computer science. On prerequisite specifications, all the CS prerequisites must be "C" or better.

The department's Bachelor of Science program in Computer Science is fully accredited by the Computing Sciences Accreditation Commission (CSAC).

CORE COURSES*

(Required of all students)

Discrete Structures	CS	130	(4)
Introduction to Computer Science	CS	140	(4)
Introduction to Programming and Problem Solving	CS	141	(4)
Computer Logic	CS	210	(4)
Data Structures and Algorithms I	CS	240	(4)
Data Structures and Algorithms II	CS	241	(4)
Assembly Language Programming	CS	264	(4)
Numerical Methods	CS	301	(4)
Formal Languages	CS	310	(4)
Design and Analysis of Algorithms	CS	331	(4)
Symbolic Programming	CS	352	(4)
Computer Organization	CS	365	(4)
Microprocessor Systems	CS	405	(4)
Programming Languages	CS	408	(4)
Artificial Intelligence	CS	420	(4)
Operating Systems	CS	431	(4)
Database Systems	CS	435	(4)
Compiler Design	CS	440	(4)
Undergraduate Seminar	CS	463	(2)
Computer Science Electives (including 12 units from the following list)			(16)

* A 2.0 cumulative GPA is required in corecourses including option courses for the major in order to receive a degree in the major.

Introductory Computer Graphics	CS	245	(4)
Parallel Processing	CS	370	(4)
Introduction to Computer Networks	CS	380	(4)
Computer Simulation	CS	390	(4)
Advanced Operating Systems	CS	432	(4)
Compiler Design	CS	441	(4)
Computability	CS	450	(4)
Advanced Computer Graphics	CS	445	(4)
Secure Communication	CS	460	(4)
Software Engineering	CS	480	(4)
Software Engineering	CS	481	(4)
Honors	CS	490	(4)

SUPPORT COURSES

(Required of all students)

General Physics	PHY	132	(3)
General Physics	PHY	133	(3)
General Physics Lab	PHY	152L	(1)
General Physics Lab	PHY	153L	(1)
General Chemistry	CHM	111	(3)
General Chemistry	CHM	151L	(1)
Analytic Geometry and Calculus	MAT	116	(4)
Linear Algebra	MAT	208	(4)
Calculus of Several Variables	MAT	214	(3)
Statistical Methods for Computer Scientists	STA	326	(4)

GENERAL EDUCATION COURSES

(Required of all students)

Area 1:

Freshman English I	ENG	104	(4)
other			(8)

Area 2:

Life Science	BIO	110	(3)
Analytic Geometry and Calculus	MAT	114	(4)
Analytic Geometry and Calculus	MAT	115	(4)
General Physics	PHY	131	(3)
General Physics Lab	PHY	151L	(1)
Other			(4)

Areas 3-5:

as required by the University	(44)
UNRESTRICTED ELECTIVES	(6)

MINOR IN ARTIFICIAL INTELLIGENCE

Required Courses

Discrete Structures	CS	130	(4)
Introduction to Computer Science	CS	140	(4)
Introduction to Programming and Problem Solving	CS	141	(4)
Data Structures and Algorithms I	CS	240	(4)
Data Structures and Algorithms II	CS	241	(4)
Formal Languages	CS	310	(4)
Symbolic Programming	CS	352	(4)
Artificial Intelligence	CS	420	(4)
Cognitive Processes	PSY	334	(4)
Logic and Semantics	PHL	202	(4)

Total units required for the Minor:	40

MINOR IN COMPUTER SYSTEMS ORGANIZATION **

Required Courses

Discrete Structures	CS	130	(4)
Introduction to Computer Science	CS	140	(4)
Introduction to Programming and Problem Solving	CS	141	(4)
Data Structures and Algorithms I	CS	240	(4)

Data Structures and Algorithms II	.CS	241	(4)
Computer Logic	.CS	210	(4)
Assembly Language Programming	.CS	264	(4)
Computer Organization	.CS	365	(4)
Microprocessor Systems	.CS	405	(4)
Operating Systems	.CS	431	(4)

Total units required for the Minor:. 40

MINOR IN SCIENTIFIC COMPUTER PROGRAMMING **

Required Courses

Discrete Structures	.CS	130	(4)
Introduction to Computer Science	.CS	140	(4)
Introduction to Programming and Problem Solving	.CS	141	(4)
Data Structures and Algorithms I	.CS	240	(4)
Data Structures and Algorithms II	.CS	241	(4)
Numerical Methods	.CS	301	(4)
Choose 3 of the following courses:			
Intro Computer Graphics	.CS	245	(4)
Design and Analysis of Algorithms	.CS	331	(4)
Computer Simulation	.CS	390	(4)
Numerical Methods in Differential Equations	.MAT	402	(4)

Total units required for the Minor:. 36

Course Descriptions

CS 101 Introduction to Computers for Non-CS Majors (4)

Basic concepts of computer hardware and software. Computer literacy. Detailed instruction in the use of a microcomputer software package including word processor, spreadsheet and database manager. Computer applications, impact of computers on society, responsibilities of the user. 4 lecture/problems. Not open to CS majors.

CS 120 Pascal (4)

The stored program computer, central processing unit, memory, input/output, control of information flow. Simple data types, loop control, conditional statements, file I/O. Structured data types: arrays, records, sets, strings. Functions and procedures. Problem analysis and algorithm design. 4 lecture/problems. Prerequisites: MAT 105 and MAT 106 with grades of C or better, or consent of instructor.

CS 125 FORTRAN (4)

Data types, evaluation of expressions, control statements, functions and subroutines, interactive and file I/O. Program development, documentation, and testing. Problem analysis and algorithm design. Applications to numeric problems and character processing. 4 lecture/problems. Prerequisites: MAT 105 and MAT 106 with grades of C or better, or consent of instructor.

CS 130 Discrete Structures (4)

Fundamental topics for Computer Science, such as logic, proof techniques, sets, basic counting rules, relations, functions and recursion, graphs and trees. Prerequisite: MAT 105 with a grade of C or better, or consent of instructor.

CS 140 Introduction to Computer Science (4)

Basic concepts of Computer Science, including overview of hardware and software. Ethical and social impacts of computing. Problem solving methods. Programming in a high-level language. Written essay required. Prerequisite: MAT 114 with a grade of C or better, or concurrent enrollment in MAT 114, or consent of instructor.

**Completion of this minor also satisfies the Category VII General Education Requirement. This minor may not be earned by Computer Science majors.

CS 141 Introduction to Programming and Problem Solving (4)

Program design and development, documentation and testing of written programs. Modularization and reusability of software. Input, output and auxiliary storage. Prerequisite: CS 140 with a grade of C or better, or consent of instructor.

CS 200 Special Problems for Lower Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CS 210 Computer Logic (4)

Boolean algebra with applications to computers and logic design. The Arithmetic Logical Unit, logical properties of flip-flops and sequential machines. Applied projects. 4 lecture/problems. Prerequisite: CS 130 with a grade of C or better, or consent of instructor.

CS 240 Data Structures and Algorithms I (4)

Abstract data types. Searching and sorting. Linked lists, stacks, queues, sets. Analysis of algorithms. Sequential files. Prerequisite: CS 130 and CS 141 with grades of C or better, or consent of instructor.

CS 241 Data Structures and Algorithms II (4)

Trees, graphs, hash tables. Random access and indexed files. Prerequisite: CS 240 with a grade of C or better, or consent of instructor.

CS 245 Introductory Computer Graphics (4)

Basic concepts in 2-dimensional graphics. Display devices, programming for vector and raster graphics, language structure and components, 2-dimensional transformations, windowing, clipping, simple hidden line removal, coloring. 4 lecture/problems. Prerequisite: CS 241 with a grade of C or better, or consent of instructor.

CS 264 Assembly Language Programming (4)

Assembly and machine coding of computers. Archetypal Von Neumann architecture and cycle of operation, instruction sets, addressing modes, macros and system I/O. Applied programming projects. 4 lecture/problems. Prerequisite: CS 210 and CS 240 with grades of C or better, or consent of instructor.

CS 299/299A/299L Special Topics for Lower Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of instructor. Instruction is by lecture, laboratory or a combination of both.

CS 301 Numerical Methods (4)

Error analysis, zeros of a function, systems of linear equations, interpolation, Chebyshev approximation, least squares approximation, numerical integration and differentiation, random processes. 4 lecture/problems. Prerequisites: MAT 208 and MAT 214 and either CS 125 or CS 141 with grades of C or better, or consent of instructor.

CS 310 Formal Languages (4)

Regular and context-free grammars and languages, acceptors, ambiguity, closure properties, normal forms, non-deterministic machines, limitations of context-free languages. 4 lecture/problems. Prerequisite: CS 210 and CS 240 with grades of C or better, or consent of instructor.

CS 331 Design and Analysis of Algorithms (4)

Development of algorithms, top-down structured programming, program correctness, backtrack programming, branch and bound methods, efficient algorithm implementation, algorithm complexity analysis. 4 lecture/problems.

Prerequisite: CS 241 and MAT 116 with grades of C or better, or consent of instructor.

CS 352 Symbolic Programming (4)

Languages for processing symbolic data with emphasis on applications in artificial intelligence. Coverage of Lisp and Prolog. 4 lecture/problems. Prerequisite: CS 241 with a grade of C or better, or consent of instructor.

CS 354 System Development Languages (4)

Advanced programming in a language suitable for the development of system utilities, operating systems and applications software systems. Emphasis on the development process and on maintainability. Examination of the relative roles of the program and the operating system. Analysis of efficiency and portability concerns. Prerequisite: CS 241 and CS 264 with grades of C or better, or consent of instructor.

CS 365 Computer Organization (4)

Fundamental characteristics of logical devices used in an architecture. Application of logic devices in a processing systems context. Study and construction of a 4-bit processor. Development and application of instruction sets and microcode. 4 lecture/problems. Prerequisite: CS 264 and PHY 133 with grades of C or better, or consent of instructor.

CS 370 Parallel Processing (4)

The taxonomy of concurrent and parallel systems. Communication and synchronization, multicomputer and multiprocessor systems. Shared-memory and message passing programming paradigms; parallel problem solving. 4 lecture/problems. Prerequisite: CS 331 with a grade of C or better, or consent of instructor.

CS 380 Introduction to Computer Networks (4)

Network architectures and layered protocols. Network service interfaces; addressing and routing; flow and congestion control. Local and metropolitan area networks. Higher level protocols. 4 lecture/problems. Prerequisite: CS 241 and CS 365 with grades of C or better, or consent of instructor.

CS 390 Computer Simulation (4)

Overview of computer simulation. Model building, implementation, validation. Discrete and continuous simulation models. Use of the languages GPSS, Simscript, Dynamo. 4 lecture/problems. Prerequisite: STA 326 and either CS 125 or CS 141 with grades of C or better, or consent of instructor.

CS 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

CS 405 Microprocessor Systems (4)

The microprocessor and support integrated circuits (ICs) as a unified system and their programming implications. Study and application of ICs for communications, peripheral adaptors, arithmetic processors, floppy disc and CRT controllers in a system context. 4 lecture/problems. Prerequisite: CS 365 with a grade of C or better, or consent of instructor.

CS 408 Programming Languages (4)

Formal definition of programming languages. Global properties of algorithmic languages including scope of declarations, storage allocation, grouping of statements, binding time, subroutines, coroutines. List processing, string manipulation and data description. Run time representation of program and data structures. 4 lecture/problems. Prerequisite: CS 241, CS 264, and CS 352 with grades of C or better, or consent of instructor.

CS 420 Artificial Intelligence (4)

Heuristic programming, searching problem spaces, theorem proving programs, game playing programs, decision making programs, question answering programs. Consideration of ethical and social dilemmas posed by AI. Technical paper required. 4 lecture/problems. Prerequisite: CS 352 with a grade of C or better, or consent of instructor.

CS 431 Operating Systems (4)

Modern operating systems overview. Loading, linking, address binding and memory management. Processes and their synchronization primitives, resource management. Monitors and kernels . Multiprogramming and multiprocessing. Concurrent operations and hardware I/O. Deadlock, file management and job control. Issues of security, privacy and property rights as they relate to operating system functions. Technical paper required. 4 lecture/problems. Prerequisite: CS 241 and CS 264 with grades of C or better, or consent of instructor.

CS 432 Advanced Operating Systems (4)

Current trends and issues in the development of operating systems. The role of operating systems in complex architectures. Detailed examination of the internal algorithms and data structures of one or more specific operating systems. 4 lecture/problems. Prerequisite: CS 431 with a grade of C or better, or consent of instructor.

CS 435 Database Systems (4)

Database system fundamentals. Physical file organization: SAM, ISAM, DAM and multi-index systems. Data models: relational, network, hierarchial and E-R. DDL and DML design and implementation. DBMS design issues including interrogation, maintenance, concurrency, recovery and security. Individual and organizational concerns regarding accuracy and privacy of data. Technical paper required. 4 lecture/problems. Prerequisite: CS 241 with a grade of C or better, or consent of instructor.

CS 440 Compiler Design (4)

Lexical analysis, parsing and basic compiling techniques including syntax-directed translation. 4 lecture/problems. Prerequisite: CS 241, CS 264 and CS 310 with grades of C or better, or consent of instructor.

CS 441 Advanced Compiler Design (4)

Run-time environments, parsing techniques, intermediate code generation and optimization, object code generation and optimization. 4 lecture/problems. Prerequisite: CS 440 with a grade of C or better, or consent of instructor.

CS 445 Advanced Computer Graphics (4)

Advanced concepts in the design of 3-dimensional graphics. Transformations, curve and patch generation, hidden line and surface removal, shading, animation. Interactive graphics applications in CAD/CAM. 4 lecture/problems. Prerequisite: CS 245 with a grade of C or better, or consent of instructor.

CS 450 Computability (4)

Turing machines, RAM machines, primitive and mu recursion, Godel numbering, Church-Turing thesis, decidability, Markov and Post systems, algorithmically unsolvable problems. 4 lecture/problems. Prerequisite: CS 310 with a grade of C or better, or consent of instructor.

CS 460 Secure Communication (4)

Public-key systems, digital signatures, ciphers, the Data Encryption Standard, access security, control of information flow. 4 lecture/problems. Prerequisite: Senior standing in Computer Science and CS 301 with a grade of C or better, or consent of instructor.

CS 461, 462 Senior Project (2)(2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum of 120 hours total time.

CS 463 Undergraduate Seminar (2)

Technical presentations by students on current developments in computer science. Seminar discussions of ethical, social and economic impacts of technology. Essays on seminar topics. 2 lecture/discussions. Prerequisite: Senior standing in computer science and a passing score on GWT.

CS 475 Computers and Society

Social, ethical, legal, political and economic issues associated with computing. Analysis of issues in written essays; discussion of case studies. Exposure to issues through a skills acquisition exercise. 4 seminars. Prerequisite: ENG 104. Computer experience recommended.

CS 480, 481 Software Engineering (4)(4)

Software engineering process including requirements engineering, specification techniques, design concepts and methods, software testing and integration concepts, verification and validation, quality assurance and configuration management, post development software evolution and documentation. 4 lecture/problems. Prerequisite: CS 241 with a grade of C or better, or consent of instructor.

CS 490 Honors (4)

In-depth study of a topic of current interest to computer science. Students will be expected to perform individual research and projects and present their results in class. Enrollment is limited. 4 lecture/problems. Prerequisite: consent of instructor.

CS 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: consent of instructor. Instruction is by lecture, laboratory or a combination of both.

GEOLOGICAL SCIENCES

John A. Klasik, *Chair*

David R. Berry   Lawrence J. Herber
David R. Jessey   Donald W. Tarman

The Geological Sciences Department offers two programs leading to either a Bachelor of Science or a Bachelor of Arts degree. The Bachelor of Science program prepares students for graduate school or direct employment in industry or government as professional geoscientists. The curriculum stresses a background in the physical sciences and mathematics as well as geology itself.

The Bachelor of Arts program offers a flexible curriculum which can be tailored to each student's specific academic goal. Anchored on a minimal number of core and support courses, the student's program can be directed into any Earth Science-related career field. The degree is aimed at those individuals who either have a general interest in geology or who have very specific career objectives in fields requiring general geologic knowledge. Examples of those related career fields are museum curators, environmental technician, Forest Service and National Park Service staff and Earth Science elementary and secondary school teachers. The student's specific bachelor of arts course program must be approved by the faculty advisor as soon as possible after entering the university.

The Minor in Geology provides an opportunity for students majoring in disciplines other than Geology to receive credit for having completed at least 30 quarter units of concentrated study in Geology. This may improve employment opportunities with Federal agencies, private companies and teaching institutions.

For those planning a career as a secondary school science teacher, a single subject credential in Science is required. This credential is obtained by completing coursework in Education and passing the National Teacher Examination. The latter can be waived by taking the courses listed in the Waiver Program. See the Director of the Center for Education and Equity in Mathematics, Science and Technology for additional information.

CORE COURSES FOR MAJOR*

(Required of all students)

GEOLOGY (BACHELOR OF SCIENCE)

Principles of Geology	GSC	111	(3)
Earth, Time and Life	GSC	112	(3)
Principles of Geology Laboratory	GSC	141L	(1)
Principles of Geology Field Trips	GSC	142L	(1)
Earth, Time and Life Lab	GSC	151L	(1)
Computer Graphics for Geologists	GSC	175L	(2)
Mineralogy	GSC	215/215L	(3/2)
Hand Specimen Petrology	GSC	219/219L	(2/2)
Geomorphology	GSC	323/323L	(3/1)
Optical Mineralogy	GSC	325/325L	(2/2)
Invertebrate Paleontology	GSC	331/331L	(3/1)
Stratigraphy	GSC	332/332L	(3/1)
Structural Geology	GSC	333/333L	(3/1)
Sedimentary Petrology	GSC	423/423L	(2/2)
Igneous and Metamorphic Petrology	GSC	424L	(3)
Ig. & Met. Petrography	GSC	425L	(2)
Igneous and Metamorphic Ore Deposits	GSC	433/433L	(3/1)
or Sedimentary & Industrial Minerals	GSC	434/434L	3/1
Field Methods	GSC	455/455L	(1/3)
Senior Thesis	GSC	461	(2)
Senior Thesis	GSC	462	(2)
Senior Seminar	GSC	463	(2)
Summer Field Geology	GSC	490	(8)

Total . . . . (71)

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* A 2.0 cumulative GPA is required in corecourses including option courses for the major in order to receive a degree in the major.

EARTH SCIENCES (BACHELOR OF ARTS)

Principles of Geology	GSC	111	(3)
Earth, Time and Life	GSC	112	(3)
Principles of Geology Lab	GSC	141L	(1)
Principles of Geology Lab (Field Trips)	GSC	142L	(1)
Earth, Time and Life Lab	GSC	151L	(1)
Mineralogy	GSC	215/215L	(3/2)
Hand Specimen Petrology	GSC	219/219L	(2/2)
Meteorology or	GSC	304	(4)
Climatology	GEO	303	(4)
Geomorphology	GSC	323/323L	(3/1)
Descriptive Physical Oceanography	GSC	335	(4)
Senior Thesis	GSC	461	(2)
Senior Thesis	GSC	462	(2)
Senior Seminar	GSC	463	(2)

Total . . . . (36)

Plus 20 additional credits in Geological Sciences or Geological Science-related course work. No more than 12 units of non-GSC credits will be accepted in the core. . . . . (23)

SUPPORT AND ELECTIVE COURSES

(Required of specific options)

GEOLOGY (BACHELOR OF SCIENCE)

General Chemistry	CHM	112	(3)
General Chemistry	CHM	113	(3)
General Chemistry Lab	CHM	152L	(1)
General Chemistry Lab	CHM	153L	(1)
Pascal	CS	120	(4)
or FORTRAN	CS	125	(4)
or Geographic Information Systems	GEO	440	(4)
Analytic Geom & Calc	MAT	115	(4)
Analytic Geom & Calc	MAT	116	(4)
General Physics	PHY	131	(3)
General Physics	PHY	132	(3)
General Physics	PHY	133	(3)
General Physics Lab	PHY	151L	(1)
General Physics Lab	PHY	152L	(1)
General Physics Lab	PHY	153L	(1)
Statistics	STA	120	(4)

Total . . . . (36)
Units to Complete GE . . . . (72-73)
Unrestricted Electives. . . . . (18-19)

EARTH SCIENCES (BACHELOR OF ARTS)

College Chemistry	CHM	105	(3)
College Chemistry	CHM	106	(3)
College Chemistry Lab	CHM	142L	(1)
College Chemistry Lab	CHM	143L	(1)
College Algebra	MAT	105	(4)
College Physics	PHY	121	(3)
College Physics	PHY	122	(3)
College Physics	PHY	123	(3)
College Physics Lab	PHY	141L	(1)
College Physics Lab	PHY	142L	(1)
College Physics Lab	PHY	143L	(1)
Intro to Stat	STA	120	(4)
Digital Image Processing	GEO	420	(4)
Geographic Information Systems	GEO	440	(4)

Total . . . . (36)
Courses to Satisfy General Education Requirements . . . . (72-73)
Other electives to be approved by advisor generally in Geological Science related fields; e.g., Soils, Civil Engr., Computer Sci.. . . . . (11)

Unrestricted Electives . . . . (7-8)

GENERAL EDUCATION COURSES (BS)

TRACK B

Area 1:

A. Freshman English I . . . . .ENG   104   (4)
B. and two additional courses . . . . (8)

Area 2:

A. Analytic Geom & Calc . . . . .MAT   114   (4)
B. General Chemistry/Laboratory . . . . .CHM   111/151L   (3/1)
C. Basic Biology . . . . .BIO   115/115L   (3/2)
     or Life Science . . . . .BIO   110/111L   3/1
D. Elective (Upper Division)

Area 3:

Select one course from each area. Minimum total. . . . . (28)

Area 4:

United States History . . . . .HST   202   (4)
Intro to American Government . . . . .PLS   201   (4)

Area 5: (Upper Division) SEE ADVISOR   (8)

GENERAL EDUCATION COURSES (BA)

Area 1:

A. Freshman English . . . . .ENG   104   (4)
B. Two additional courses. . . . . (8)
C.

Area 2:

A. Trigonometry . . . . .MAT   106   (4)
B. College Chemistry/Laboratory . . . . .CHM   104/141L   (3/1)
C. Basic Biology . . . . .BIO   115/115L   (3/2)
     or Life Science . . . . .BIO   110/111L   3/1
D. Elective

Area 3:

Select one course from each area. Minimum total. . . . . (28)

Area 4:

United States History . . . . .HST   202   (4)
Intro to American Govt . . . . .PLS   201   (4)

Area 5:   (Upper Division) SEE ADVISOR   (8)

MINOR IN GEOLOGY

Minimum units 33
Minimum lower-division units 17*
Minimum upper-division units 12
Principles in Geology . . . . .GSC   111   (3)
Principles of Geology Lab . . . . .GSC   141L   (1)
Principles of Geology Field Trips . . . . .GSC   142L   (1)
Earth, Time, and Life . . . . .GSC   112   (3)
Earth, Time, and Life Lab . . . . .GSC   151L   (1)
Hand Specimen Petrology . . . . .GSC   219/219L   (2/2)
It is required that the student confer with a minor advisor in the planning and selection of the minor curriculum.

* Excluding GSC 101.

Course Description

NOTE: For all courses which have both a lecture component and a laboratory component (e.g., GSC 215/215L), both components are corequisites; that is, they must be taken concurrently.

F, W, Sp and Su notations indicate the quarter(s) each course is normally offered. Unless otherwise specified, the course is offered each year during the indicated quarter(s). Parentheses signify that the course may be offered during the quarter(s) they enclose. Courses approved for CR/NC grading designated by a dagger (+) (non-majors only).

Field Trip Fee is required for various courses to cover transportation costs and varies according to type of transportation used.

+GSC 101/101A Fundamentals of Earth Science (3/1) FWSp(Su)

A broad ranging non-quantitative examination of basic concepts in the physical earth sciences. Subject areas are geology, oceanography, the atmosphere and the Earth's place in the solar system. 3 lecture hours and 1 recitation hour per week. Does not satisfy laboratory science requirement.

+GSC 111 Principles of Geology (3) FWSp(Su)

An introduction to minerals, rocks and geologic features which comprise the Earth; analysis of internal and external processes controlling the features of the planet. 3 lecture hours per week. Corequisite: GSC 141L and 142L (optional for non-majors).

+GSC 112 Earth, Time and Life (3) W

Changes in continents and ocean basins, fossil populations during successive geological ages, 3 lectures. May be taken without lab by non-majors.

+GSC 115 Astronomy of the Solar System (3) F

Introduction to the modern concepts of astronomy, including the historical development of astronomy and the origin and evolution of the Solar System, with a special emphasis on recent discoveries about the planets. 3 lectures.

+GSC 116 Astronomy of the Universe (4) Sp

Methods, principles and instruments used in astronomical investigations. Examination of physical and chemical properties of stars. Theories as to origin, state and future of the universe. A consideration of man's place in the cosmos. 4 lecture/discussions.

+GSC 117L Astronomy Laboratory (1)

Provides student with experience in use of planetary data sets. Lab exercises will include studies of planetary and lunar surfaces, planetary motion, tides and atmospheres. 1 3-hour laboratory. Prerequisite or concurrent enrollment: +GSC 115 or consent of instructor.

+GSC 120 Introduction to Oceanography (4) FWSp(Su)

An introduction to the marine sciences. Dealing primarily with the properties of water, ocean currents, waves, tides, beaches, marine life, marine resources and the nature and origin of the sea floor. 4 lectures. Field trip fee required.

+GSC 141L Principles of Geology Laboratory (1) FWSp(Su)

Classification of minerals and rocks. Reading and interpreting topographic and geologic maps. One 3-hour lab. Must be taken concurrently with +GSC 111 or permission of instructor. Lab optional for non-majors.

GSC 142L Principles of Geology Field Trips (1)

Field trips to study features of geologic interest in Southern California. Two full-day Saturday field trips. Must be taken concurrently with GSC 111. Does not meet lab science requirement. Optional for non-majors. Field trip fee required.

GSC 151L Earth, Time and Life Laboratory (1) W

Classification of fossil invertebrates, studies of paleogeographic maps and geologic maps and problems in structural geology. One 3-hour laboratory. Must be taken concurrently with GSC 112 or permission of instructor. Optional for non-majors. Field trips required. Field trip fee required.

GSC 175L Computer Graphics for Geologists (2) Sp

Application of computer graphics to the solution of geological problems and the preparation of geological diagrams and geological reports. Course emphasizes AutoCad based drafting, digitizing and data output, graphical user interfaces (GUI's) and computer illustration/graphic design software instruction. 2 3-hour laboratories. Prerequisites: GSC 111, 141L.

GSC 200 Special Problems for Lower Division Students (1-2) FWSpSu

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with the maximum of 2 units per quarter.

GSC 215/215L Mineralogy (3/2) F

Identification, occurrence, origin and uses of the common rock-forming minerals. Blowpipe and qualitative spectroscopic analysis. Physical and chemical properties of minerals and introductory morphologic crystallography. 3 lecture/problems, 2 three-hour laboratories. Prerequisites: GSC 111 (including lab), CHM 104 and 141L or CHM 111 and 151L. Field trip fee required.

GSC 219/219L Hand Specimen Petrology (2/2) W

Emphasis on rock collecting and field relationships. Rock identification based largely on megascopic properties. Students will be required to make field trips and field collections. 2 lecture/problems, 2 three-hour laboratories. Prerequisites: GSC 111, GSC 141, and GSC 142L. Field trip fee required.

+GSC 250 Environmental Geology (4) FW

Application of geologic principles to selected environmental problems; topics include resources (water, minerals and energy), geologic hazards (floods, earthquakes and landslides) and environmental planning (waste disposal, construction siting and environmental impact statements). 4 lectures. Field trips required. Field trip fee required.

GSC 299/299A Special Topics for Lower Division Students (1-4/1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Permission of instructor. Instruction is by lecture/problem-solving, laboratory or a combination of both.

GSC 300/300L Introduction to Geochemistry (3/1)

The application of quantitative chemical principles to geologic processes. Emphasis is on low temperature aqueous geochemistry, isotope geochemistry and high temperature thermodynamics of silicate melts. Basic concepts of crystal chemistry, organic geochemistry and cosmic geochemistry are also introduced. 3 lecture/problems, 1 3-hour lab. Prerequisites: GSC 111, CHM 113, CHM 153L or CHM 106, CHM 143L.

GSC 304 Meteorology (4) W

Framework topics, such as atmospheric structure, composition, global heat budget, pressure and humidity form the base upon which a process-oriented, semiquantitative, descriptive survey of major weather phenomena, including winds, clouds, precipitation and storms, is conducted. 4 lecture/problems. Prerequisites: PHY 121 or consent of instructor.

GSC 321/321L Geotechnology (3/1) FSp

Fundamentals of geology applied to engineering problems. Includes rock types, structure, erosion, sedimentation, seismic explorations and rock/soil movements. 3 lecture/problems, 1 three-hour laboratory. For Civil Engineering majors. Prerequisite: ENG 104, CE 134/134L. Field trips required. Field trip fee required.

GSC 323/323L Geomorphology (3/1) W

Analysis of landscape-forming agents, especially the geomorphic work of rivers, glaciers, waves and wind. Laboratory and field study of the processes and their resulting landforms. 3 lecture/problems, 1 three-hour laboratory.

Prerequisite: GSC 111, GSC 141L and, GSC 142L. Field trips required. Field trip fee required.

GSC 325/325L Optical Mineralogy (2/2) W

The chemistry (primarily phase relationships) of the common rock-forming minerals. The description, composition, texture and origin of the common rock-forming minerals according to their optical properties as determined with the petrographic microscope. 2 lecture/problems, 2 three-hour laboratories. Prerequisite: GSC 215/215L, CHM 112 or 105 concurrently.

GSC 331/331L Invertebrate Paleontology (3/1) Sp

Morphology and evolution of fossil invertebrates. Includes discussion of ancient environments and changes in life forms with time. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: GSC 112 and GSC 151L. Field trips required. Field trip fee required.

GSC 332/332L Stratigraphy (3/1) Sp

Stratigraphic procedures, correlation, depositional environments, classification and origin of stratigraphic units. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: GSC 111, GSC 141L, GSC 142L, GSC 112 and GSC 151L. Field trips required. Field trip fee required.

GSC 333/333L Structural Geology (3/1) F

Structural features and deformation of the earth's crust. Solution of geologic field problems. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: Mat 106, GSC 175L, GSC 111L, GSC 141L and, GSC 142L. Field trips required. Field trip fee required.

GSC 334/334L Exploration Geophysics (3/1)

Geophysical techniques. Gravity, magnetic, electrical and seismic methods applied to the solution of geologic problems. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: GSC 111, GSC 141L, GSC 142L, PHY 132 and PHY 152L or PHY 122 and PHY 142L. Field trips required. Field trip fee required.

GSC 335 Descriptive Physical Oceanography (4) F

A survey of physical, chemical and geological oceanography. Emphasis centers on the major physical and chemical properties of sea water and such physical processes as ocean circulations, tides and waves. Ocean basin physiography, sedimentation and evolution are also discussed. 4 lecture/problems; cruise. Prerequisites: CHM 106 & PHY 121. Field trips required. Field trip fee required.

GSC 338 Coastal Processes (4)

Geologic development of and the hydrologic and geologic processes acting within beach, deltaic and estuarine environments. Field trip required. 4 lecture/problems. Prerequisites: GSC 111, GSC 120 or 335. Upper division standing. Field trips required. Field trip fee required.

GSC 340 Marine Geology (4)

The physiography, sedimentology, structure, origin and evolution of the ocean basins and continental margins. Facts, data, speculation derived from a variety of texts, journals, maps. 4 lecture/problems. Prerequisites: GSC 335 or 120, and GSC 111, upper division standing. Field trips required. Field trip fee required.

GSC 350/350A100 Geologic Catastrophies (4) FWSp

Scientific description, measurement and observation of geologic catastrophies resulting from active plate tectonic phenomena. Emphasis on earthquakes, volcanic eruptions, landslides and glacially-controlled sea level changes. Floods and associated erosion/deposition may also be addressed. Case histories of past geologic catastrophies. 3 hours lecture, 1 hour recitation per week.

GSC 351/351L Petroleum Geology (3/1)

Origin and occurrence of petroleum and related products. Study of the geologic structure and stratigraphy of major oil and gas fields. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: GSC 141L and GSC 151L. Field trips required. Field trip fee required.

GSC 360/360L Groundwater Geology (3/1) W

Groundwater occurrence and movement. Role in hydrologic cycle and geologic processes. Groundwater resource evaluation, geotechnical problems and contamination. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: GSC 111, GSC 141L, MAT 105 or higher, PHY 121 and PHY 141L or PHY 131 and PHY 151L.

GSC 400 Special Problems for Upper Division Students (1-2) FWSpSu

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

GSC 415/415L Engineering Geology (3/1)

Geologic site investigations; field mapping; subsurface investigations. Geologic analysis of slope stability; subsidence; geology of dam and tunnel construction; ground water geology; seismicity and active fault tectonics; urban geology and engineering geologic reports. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: GSC 111, with lab, or GSC 321/321L. Field trips required.

GSC 423/423L Sedimentary Petrology (2/2) F

Descriptive chemical, mineralogic and textural studies of sedimentary rocks, using primarily petrographic, sieve and sedimentation techniques. Theory of the classification and origin of these rocks. Field trips. 2 lectures, 2 three-hour laboratories. Prerequisite: GSC 325/325L. Field trips required. Lab fee required.

GSC 424 Igneous and Metamorphic Petrology (3) Sp

Theory of the origin, classification, chemistry and mineralogy of igneous and metamorphic rocks. 3 lectures. Prerequisites: GSC 325/325L and MAT 115. Corequisite: GSC 425L.

GSC 425L Igneous and Metamorphic Petrography (2) Sp

Mineralogy, texture and description of igneous and metamorphic rocks with the petrographic microscope, mineral separation techniques and x-ray diffraction. Field trips. Prerequisite GSC 325. Corequisite GSC 424. 2 three-hour laboratories. Field trips required. Field trip fees required.

GSC 433/433L Igneous and Metamorphic Ore Deposits (3/1) W (even years)

Geology of ore deposits in igneous and metamorphic rocks, including fluid inclusion studies, ore microscopy, stable isotope geochemistry, wall rock alteration and ore deposit modeling. Laboratory examination of ore suites, polished sections and thin sections. Field trips to selected mine localities required. 3 lectures, one 3-hour laboratory. Prerequisite: GSC 424 and GSC 425L. Field trips required. Field trip fee required.

GSC 434/434L Sedimentary Ores and Industrial Minerals (3/1) W (odd years)

Geology of sedimentary ore deposits and industrial rocks and minerals. Emphasis on economic aspects of resource recovery, occurrence and exploitation of low value/large tonnage deposits and industrial markets. Laboratory examination of thin section and polished sections, exercises in economic evaluation of ore deposits. Field trips to local mine sites required. 3 lectures, one 3-hour laboratory. Prerequisite: GSC 423/423L. Field trips required. Field trip fee required.

GSC 440/440L Exploration and Mining Geology (3/1) Sp Even Years

Planning and implementation of mineral exploration programs, resource extraction and ore processing. Course topics include mineral economics, exploration planning, exploration techniques, ore deposit valuation and mining and processing systems. Special emphasis is placed on the economic theory and practical aspects of development of precious metal properties. Lab exercises focus on all aspects of exploration from field exercises involving claim staking, geochemical/geophysical prospecting and underground mine mapping to on-campus work with computer generated ore reserve models and automated data base literature searches. 3 lectures, 1 three-hour laboratory. Prerequisites: GSC 111, GSC 215/215L and GSC 219/219L or consent of instructor.

GSC 441/441L Micropaleontology (3/1)

Morphology, classification and evolution of major plant and animal microfossil groups with emphasis on the Foraminiferida. Use of microfossils in petroleum exploration and paleoenvironmental reconstruction. 3 lecture/problems, 1 three-hour laboratory. Prerequisites: GSC 112, GSC 151L and GSC 331/331L or permission of instructor.

GSC 444/444L Geotectonics (3/1)

Study of the major tectonic elements of the Earth, their geometry, kinematics and dynamics with special emphasis on the Cordillera of Western North America. All of the tectonic features will be analyzed in the context of plate tectonics. Prerequisites: GSC 219/219L and GSC 333/333L. Field trips required. 3 lecture/problems, 1 three-hour lab.

GSC 455/445L Field Methods (1/3) Sp (even years)

Techniques of recognizing, mapping, analyzing and interpreting geologic structures and earth features. Surveying with plane table, alidade, Brunton compass and tape. 1 lecture/problem, 3 three-hour laboratories. Prerequisites: GSC 219/219L and GSC 333/333L. Field trips required. Field trip fee required.

GSC 461, 462 Senior Thesis (2) F W Sp

Independent research study into a geologic problem of scientific merit following standard scientific methodology. Topic selection, research techniques, data analysis and formal write up are done under close guidance and supervision of a GSC faculty research advisor. Successful completion of GSC 461, 462 requires submission of a formal, written report in appropriate scientific style. In certain cases, publication of research results in appropriate scientific journal or as an abstract may be accepted in lieu of report.

GSC 463 Senior Seminar (2) F W Sp

A formal, oral presentation of senior thesis results. This presentation will be judged on clarity, organization, scientific merit and the presenter's ability to discuss and to respond to faculty and student questioning in an effective and persuasive manner. Students should not enroll in GSC 463 until senior thesis is near completion.

GSC 490L Summer Field Geology (8) Su (even years)

A six-week course in geological field methods. Preparation of geological maps of metamorphic, igneous and sedimentary rock areas. Geologic report on areas mapped. Prerequisite: GSC 455/455L. Field trip fee required.

GSC 499/499A/499L Special Topics for Upper Division Students (1-4) FWSpSu

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units with a maximum of 4 units per quarter. Prerequisite: permission of instructor. Instruction is by lecture, laboratory or a combination of both.

MATHEMATICS

Claudia Pinter-Lucke, *Chair*

Charles Amelin	Bernard Banks
Hasan Celik	Yu Chang
Gregory E. Chamblee	Tse-yee Chen
Hsin Ya Fan	Carlos Ford-Livene
Dhanwant Singh Gill	Frank Glaser
Jack E. Hofer	Donald Hook
Larry D. Irwin	Judith Jacobs
Thomas M. King	Alan Krinik
Kei A. Lee	Harriet Lord
Daniel A. Marcus	Henryka Maslowski
Frank P. Mathur	Jim McKinney
Lilian Metlitzky	John C. Morgan, II
Martin Nakashima	Kamta Rai
Alan Radnitz	Richard A. Robertson
Judy Reeves	Carol Smith
Barbara Shabell	Weiqing Xie
V. Merriline Smith	

The Mathematics Department offers a flexible major program which may be adapted to serve a variety of needs and interests. The student may develop elective patterns which will prepare him/her for entry into employment in industry and government.

However, each student is urged to develop an elective pattern which will also be preparatory for graduate study either in mathematics or in some quantitative discipline in the sciences, engineering, economics or business. Courses at the 500-level are available as part of a Master's degree graduate program.

The Mathematics Department recommends that each student use several free electives to develop depth in some discipline other than mathematics.

Transfer students should complete as much of the calculus sequence as possible before entering Cal Poly. Chemistry and physics courses to be transferred should be those which require calculus concurrently or as a prerequisite.

A high school student planning a major in mathematics should complete one year of physics, one year of chemistry and four years of mathematics to include thorough preparation in trigonometry and advanced algebra.

Students majoring in mathematics and who have at least a 3.0 GPA may join the honorary society, Kappa Mu Epsilon. Additional information can be obtained from the Department of Mathematics.

CORE COURSES FOR MAJOR*

(Required of all students)

Pascal	CS	120	(4)
or FORTRAN	CS	125	
Applied Probability Theory	STA	330	(4)
Applied Statistics	STA	331	(4)
Analytic Geometry and Calculus	MAT	115	(4)
Analytic Geometry and Calculus	MAT	116	(4)
Intro to Numerical Methods	MAT	201	(4)
Introduction to Linear Algebra	MAT	208	(4)
Calculus of Several Variables	MAT	214	(3)
Calculus of Several Variables	MAT	215	(3)
Differential Equations	MAT	216	(4)
Basic Set Theory and Logic	MAT	310	(4)
Intermediate Analysis	MAT	314	(4)
Intermediate Analysis	MAT	315	(4)
Modern Algebra	MAT	417	(4)
Modern Algebra	MAT	418	(4)
Complex Variables	MAT	428	(4)

OPTION COURSES FOR MAJOR*

(Required for specific option)

PURE MATHEMATICS

Choose six courses from the following list. No more than two Geometry courses may be selected from MAT 330, MAT 415, MAT 416, MAT 420.

History of Mathematics	MAT	306	(4)
Topology	MAT	321	(4)
Introduction to Number Theory	MAT	325	(4)
Modern Euclidean Geometry	MAT	330	(4)
Advanced Calculus	MAT	413	(4)
Foundations of Geometry	MAT	415	(4)
Projective Geometry	MAT	416	(4)
Abstract Linear Algebra	MAT	419	(4)
Differential Geometry	MAT	420	(4)
Functions of a Complex Variable	MAT	429	(4)
Foundations of Mathematics	MAT	450	(4)

APPLIED MATHEMATICS

The student must complete two two-quarter sequences from the list below:

Mathematics of Operations Research	MAT	380	(4)
Mathematics of Operations Research	MAT	381	(4)
Numerical Analysis	MAT	401	(4)
Numerical Analysis	MAT	402	(4)
Differential Equations	MAT	431	(4)
Differential Equations	MAT	432	(4)
Math. Modeling and Simulation	MAT	485	(4)
Math. Modeling and Simulation	MAT	486	(4)

The student must complete two additional courses from the list above or the list below:

Graph Theory	MAT	370	(4)
Mathematics of Operations Research	MAT	382	(4)
Combinatorics	MAT	470	(4)
Mathematical Programming	MAT	480	(4)

STATISTICS

Choose 16 units from the following:

Nonparametric Statistics	STA	320	(4)
Applied Regression	STA	432	(4)
Stochastic Processes	STA	430	(4)
ANOVA and Design of Experiments	STA	435	(4)
Mathematical Statistics I	STA	440	(4)
Mathematical Statistics II	STA	441	(4)
Special Topics	STA	499	(1-4)
Computer Simulation	CS	390	(4)

Choose 8 units in consultation with your advisor.

SUPPORT AND ELECTIVE COURSES

(Required of all students)

General Chemistry	CHM	112	(3)
General Chemistry Lab	CHM	152	(1)
General Physics	PHY	132	(3)
General Physics	PHY	133	(3)
General Physics Lab	PHY	151	(1)
General Physics Lab	PHY	152	(1)
General Physics Lab	PHY	153	(1)
Unrestricted Electives			(25)

GENERAL EDUCATION COURSES

Area 1:
 ENG 104 Freshman Composition
 Choose two courses in consultation with advisor.

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* A 2.0 cumulative GPA is required in corecourses including option courses for the major in order to receive a degree in the major.

Area 2:

A. MAT 114 Analytical Geometry and Calculus
B. CHM 111 General Chemistry
    CHM 151 General Chemistry Lab
    PHY 131 General Physics
C. BIO 110 Life Science
D. Choose in consultation with advisor (Upper Division)

Area 3:

Select one course from each area. Minimum total 28

Area 4:

U.S. History ....HST	202	(4)
Intro American Gov ....PLS	201	(4)

Area 5:

Upper Division—minimum 8

SUBJECT MATTER PREPARATION – Program for Prospective Teachers in Mathematics

The Mathematics Department offers a program in mathematics approved by the Commission on Teacher Credentialing. Those individuals who wish to become mathematics teachers in California public schools must complete the comprehensive list of courses that follows. The core courses in the mathematics major together with appropriate selected courses in the pure option will satisfy most of the courses on the list. The rest of the required courses can be chosen to satisfy the free elective requirements for the degree.

Analytic Geometry and Calculus I ....MAT	114	(4)
Analytic Geometry and Calculus II ....MAT	115	(4)
Analytic Geometry and Calculus III ....MAT	116	(4)
Introduction to Linear Algebra ....MAT	208	(4)
Calculus of Several Variables I ....MAT	214	(3)
Calculus of Several Variables II ....MAT	215	(3)
History of Math ....MAT	306	(4)
Introduction to Logic and Set Theory ....MAT	310	(4)
Intermediate Analysis I ....MAT	314	(4)
Introduction to Number Theory ....MAT	325	(4)
Modern Euclidean Geometry ....MAT	330	(4)
Foundations of Geometry ....MAT	415	(4)
or Projective Geometry ....MAT	416	
Modern Algebra I ....MAT	417	(4)
Modern Algebra II ....MAT	418	(4)
Topics and Issues in Contemporary		
Secondary School Mathematics ....MAT	495	(4)
Topics and Issues in Contemporary		
Secondary School Mathematics ....MAT	496	(4)
Topics and Issues in Contemporary		
Secondary School Mathematics ....MAT	497	(4)
Applied Probability Theory ....STA	330	(4)
Applied Statistics ....STA	331	(4)
Pascal ....CS	120	(4)
or a college-level course in C		
Select one course from the following:..............................		(4)

  MAT 201, 370, 380, 480, 485,
  CS 390, CHE 415, OM 419, STA 432, STA 435

MINOR IN MATHEMATICS

Analytic Geometry and Calculus ....MAT	114	(4)
Analytic Geometry and Calculus ....MAT	115	(4)
Analytic Geometry and Calculus ....MAT	116	(4)
Calculus of Several Variables ....MAT	214	(3)
Calculus of Several Variables ....MAT	215	(3)
Differential Equations ....MAT	216	(4)
Introduction to Linear Algebra ....MAT	208	(4)

In addition to the above courses, choose any four upper division courses (except MAT 391,392, 400, 461,462, 463, 491, 492, 493, 495, 496, 497, STA

309, 315). No more than two upper division STA courses can be counted towards the Mathematics Minor (see Statistics Minor). No more than one of MAT 317 or MAT 318 can be counted towards the mathematics minor.

Minimum number of units required: ....(41)
It is recommended that the student confer with a minor advisor in the selection of courses. Since a maximum of flexibility is afforded, the student is cautioned to pay very careful attention to the prerequisites for the courses selected.

STATISTICS MINOR

Analytic Geometry and Calculus ....MAT	114	(4)
Analytic Geometry and Calculus ....MAT	115	(4)
Analytic Geometry and Calculus ....MAT	116	(4)
Introduction to Linear Algebra ....MAT	208	(4)
Calculus of Several Variables ....MAT	214	(3)
Calculus of Several Variables ....MAT	215	(3)
Applied Probability Theory ....STA	330	(4)
Applied Statistics ....STA	331	(4)
Applied Regression ....STA	432	(4)

Choose 8 units from the following:		
Nonparametric Statistics ....STA	320	(4)
Stochastic Processes ....STA	430	(4)
ANOVA and design of Experiments ....STA	435	(4)
Mathematical Statistics I ....STA	440	(4)
Mathematical Statistics II ....STA	441	(4)
Special Topics ....STA	499	(1-4)
Minimum number of units required:		42

For two or more courses with a common course description, each lower-numbered course must be passed with a C or better (or the student must obtain a written consent of the instructor) as a prerequisite for each higher-numbered course.

MATHEMATICS DIAGNOSTIC PLACEMENT TEST (MDPT)

There is a MDPT test prerequisite required for all introductory and GE level mathematics and statistics courses. THIS REQUIREMENT MUST BE MET WITHIN THE IMMEDIATE TWO QUARTERS PRIOR TO ENROLLMENT IN MATHEMATICS AND STATISTIC COURSES. There are three tests: Basic Algebra (for MAT 009, 010, 011); Intermediate Algebra (for MAT 12, 105, 106, 125, 135, 137, 191, STA 120); and Precalculus (for MAT 112, 114, 120, 130). All test results include cutoff scores for lower level courses. Tests are given each quarter, including summer quarter. Students must register in advance at the Mathematics Diagnostic Test desk (Bldg. 8, Room 108).

PREPARATORY MATHEMATICS PROGRAM

A four-quarter sequence of courses is provided for students needing intensive mathematics review in order to enroll in General Education mathematics or statistics courses. All courses include weekly tutorial-laboratories. Courses receive unit load credit but not baccalaureate credit. Students must have achieved prerequisite scores on ELM or MDPT in order to enroll in MAT 010, 011, 012. A grade of C or better in MAT 010 will waive the MDPT requirement for MAT 011. A grade of C or better in MAT 011 will waive the MDPT requirement for MAT 012. A grade of C or better in MAT 012 will waive the MDPT requirement for MAT 105, 106, 125, 135, 137, 191, STA 120. A waiver of any MDPT requirement is valid for two (2) quarters only and applies only to those courses taken at Cal Poly.

Course Descriptions

F, W, Sp, and Su notations indicate the quarter(s) each course is normally offered. Unless otherwise specified, the course is offered this year during the indicated quarter(s).

Students subject to the CSU system required Entry Level Mathematics test (ELM) are required to take ELM prior to enrolling in any math and statistics

course. Any course listed as a prerequisite, or equivalent to a listed prerequisite, must be passed with a C or better grade. Any test score or course grade used to satisfy a course placement prerequisite must have been earned within two quarters.

MAT 009 Introductory Mathematics (4) FWSp

Review of arithmetic with applications, measurement systems, introductory statistics, operations with integers. 4 lecture/problems. Two-hour tutorial laboratory. Letter grade only. Prerequisite: Minimum placement score on ELM or MDPT within two quarters.

MAT 010 Prealgebra (4) FWSp

Geometry, measurement geometry, introduction to algebra including variable expressions, linear equations, polynomials, techniques of factoring, integer exponents. 4 lecture/problems. Two-hour tutorial laboratory. Letter grade only. Prerequisite: Minimum placement score on ELM or appropriate MDPT or C or better in MAT 009 within two quarters.

MAT 011 Basic Algebra (4) FWSpSu

Applications of linear equations, techniques of factoring, rational expressions, linear inequalities, graphs of linear functions, systems of linear equations, rational exponents and radicals, quadratic equations. 4 lecture/problems. Two-hour tutorial laboratory. Letter grade only. Prerequisite: Minimum placement score on ELM or appropriate MDPT or C or better in MAT 010 within two (2) quarters.

MAT 012 Intermediate Algebra (4) FWSpSu

Complex numbers, advanced quadratic equations with applications, quadratic and rational inequalities, functions, conic sections, logarithms, non-linear systems of equations, sequences and series, binomial expansions. 4 lecture/problems. One-hour tutorial laboratory. Letter grade only. Prerequisite: Minimum placement score on ELM or appropriate MDPT or C or better in MAT 011 within two (2) quarters.

MAT 105 College Algebra (4) FWSpSu

Real numbers, inequalities, absolute value, coordinate systems, functions, progressions, linear and quadratic systems, polynomials and mathematical induction. Not open to any student with credit for MAT 115. 4 lecture/problems. Prerequisite: Must have satisfied ELM and have achieved the minimum placement score on the appropriate Math Diagnostic Placement Test or C or better in MAT 012 within two quarters.

MAT 106 Trigonometry (4) FWSpSu

The circular functions, general reduction formulas, inverse functions, graphs, exponential and logarithmic functions, Law of Sines, Law of Cosines, identities and complex numbers. Not open to any student with credit for MAT 115. 4 lecture/problems. Prerequisite: Must have satisfied ELM and have achieved the minimum placement score on the appropriate Math Diagnostic Placement or C or better in MAT 012 within two quarters.

MAT 112 Preparation for Calculus (4) FWSpSu

Function, theory, techniques for graphing functions (polynomials, rational functions, trig functions, exponential functions, log functions, and compositions of these such as trig polynomials), conic sections, solutions of systems of linear and non-linear equations, inequalities, introduction to limits. 4 lecture/problems. Prerequisites: Must have satisfied ELM and have achieved the minimum placement score on the appropriate MDPT or C or better in MAT 105 and MAT 106 or equivalent within two quarters.

MAT 114 Analytic Geometry and Calculus I (4) FWSpSu

Functions, limits and continuity. Derivatives and applications of derivatives including max/min applications, L'Hospital's Rule. Introduction to Integration, the Fundamental Theorem of Calculus, the Indefinite Integral integration by substitution. 4 lecture/problems. Prerequisite: Must have satisfied ELM and

have achieved the minimum placement score on the appropriate MDPT or B or better in MAT 105 and MAT 106 or equivalent or C or better in MAT 112 within two quarters.

MAT 115 Analytic Geometry and Calculus II (4) FWSpSu

Applications of the Definite Integral, Calculus of Inverse Applications including trig functions, log and exponential functions and hyperbolic functions. Integration techniques including substitution, parts, products of trig functions, partial fractions, trig substitution, quadratic forms, improper integrals. 4 lecture/problems. Prerequisite: C or better in MAT 114 or consent of the instructor.

MAT 116 Analytic Geometry and Calculus III (4) FWSpSu

Sequences and Series, Polar Coordinates, Parametric equations and Conic Sections. 4 lecture/problems. Prerequisites: C or better in MAT 115 or consent of the instructor.

MAT 120 Calculus for the Life Sciences (4)

Study of the calculus of algebraic, exponential and logarithmic functions. Graphing, limits, derivatives, differentials and integrals of single variable functions listed above. Brief introduction to partial derivatives and double integrals or multivariable functions. Special emphasis is given to applications in life sciences. 4 lecture-problems. Prerequisites: Passing score on ELM. Passing score on appropriate MDPT or C or better in MAT 105.

MAT 125 Introductory Calculus for Business (4) FWSpSu

Graphing, differentiation, integration of rational and exponential functions, with special emphasis on applications to business. Not open to any student whose major requires the MAT 114 sequence. 4 lecture/problems. Prerequisite: Must have satisfied ELM and have achieved the minimum placement score on the appropriate Math Diagnostic Placement Test or C or better in MAT 012 within two quarters.

MAT 130 Technical Calculus I (4) FWSpSu

Differential calculus of rational functions and applications of the derivative. Integral calculus and applications of the integral. 4 lecture/problems. Prerequisite: Must have satisfied ELM and have achieved the minimum placement score on the appropriate MDPT or B or better in MAT 105 and MAT 106 or equivalent or C or better in MAT 112 within two quarters.

MAT 131 Technical Calculus II (4) FWSpSu

Analytic geometry. Derivatives and integrals of trigonometric, logarithmic, and exponential functions and applications. 4 lecture/problems. Prerequisite: C or better in MAT 106 and MAT 130 or consent of instructor.

MAT 132 Technical Calculus III (4) FWSpSu

Techniques of multidimensional calculus, infinite series, introduction to ordinary differential equations and Laplace transforms. 4 lecture/problems. Prerequisite: C or better in MAT 131 or consent of instructor.

MAT 135 Contemporary Mathematics (4)

Emphasis on modern applications of selected topics from linear equations and inequalities, introduction to matrices, graphs, linear programming, sets and counting techniques, probability, decision theory, markov chains, games, logic, mathematics of finance, trees and algorithms. 4 lecture/problems. Prerequisite: Minimum placement score on ELM and appropriate MDPT and C or better in MAT 012 within two quarters.

MAT 137 Survey of Geometry (4)

Logical systems; Euclidean Geometry, Coordinate Geometry; Geometry in Space, lines, planes, volumes and surface areas; Applications. 4 lecture/problems. Prerequisites: Must have satisfied ELM and have achieved the minimum placement score on the appropriate MDPT or C or better in MAT 012 within two quarters.

MAT 191 Survey of Mathematics (4) FWSpSu

Emphasis on modern applications of selected topics from sets, logic, probability, statistics and mathematical modeling. 4 lecture-problems. Prerequisites: Passing score on ELM, two years of high school algebra, and current passing score on appropriate MDPT or C or better in MAT 012 within two quarters.

MAT 200 Special Problems for Lower Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

MAT 201 Introduction to Numerical Methods (4) FWSp

Numerical methods of topics from algebra and calculus. Topics will include function evaluation and graphing, limits, summation, solving nonlinear equations, systems of equations, numerical integration and differentiation and an introduction to numerical error. 4 lecture/ problems. Prerequisite: C or better in MAT 116 and CS 120 or CS 125 or consent of instructor.

MAT 208 Introduction to Linear Algebra (4) FWSpSu

Introduction to linear transformations of the plane, vector space of n-tuples, matrix algebra, determinants, systems of linear equations. 4 lecture/ problems. Prerequisite: C or better in MAT 214, or consent of instructor.

MAT 214 Calculus of Several Variables I (3) FWSpSu

Introduction to vectors, dot products, cross products, equations of lines and planes. Calculus of Vector Valued Functions including unit tangents,unit normals and curvature. Introduction to multivariable functions, the Differential Calculus of Multivariable Functions, the chain rule, applications including extreme problems and Lagrange multipliers. 3 lecture/problems. Prerequisite: C or better in MAT 116 or consent of instructor.

MAT 215 Calculus of Several Variables II (3) FWSpSu

Integral Calculus of Multivariable functions, double and triple Integrals, applications of double and triple integrals, line and surface integrals, Green's Theorem, Divergence Theorem, Stokes Theorem. 3 lecture/problems. Prerequisite: C or better in MAT 214 or consent of instructor.

MAT 216 Differential Equations (4) FWSpSu

The theory of ordinary differential equations with emphasis on the linear case. 4 lecture/problems. Prerequisite: C or better in MAT 116, or consent of instructor.

MAT 299/299A/299L Special Topics for Lower Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of instructor. Lecture/Activity/Lab or a combination.

MAT 306 History of Mathematics (4)

Development of mathematics over four millennia. Recommended for students preparing to teach mathematics. 4 lectures. Prerequisite: C or better in MAT 215, or consent of instructor.

MAT 310 Basic Set Theory and Logic (4) FSp

Basic set theory and logic, relations, functions, mathematical induction, countable and uncountable sets. Emphasis on how to present and understand mathematical proof. 4 lecture/problems. Prerequisite: C or better in MAT 116, or consent of instructor.

MAT 314, 315 Intermediate Analysis (4) (4) FW/WSp

Metric spaces and continuity. Analysis of functions of a single variable. Sequences, limits, continuity, differentiation, integration, introduction to function spaces. 4 lecture/problems. Prerequisite for MAT 314: C or better in

MAT 215 and MAT 310 or consent of instructor. Prerequisite for MAT 315: C or better in MAT 314, or consent of instructor.

MAT 317 Laplace Transforms and Fourier Series (3) FWSpSu

Introduction to Fourier Series and Integrals with applications. Elementary theory of Laplace transformation with applications including the solution of differential equations. 3 lecture/problems. Prerequisite: C or better in MAT 216, or consent of instructor.

MAT 318 Mathematical Analysis of Engineering Problems (3) FSpSu

Introduction to the algebra and calculus of vectors including the divergence and Stokes' theorem. Introduction to analytic functions of a complex variable. Not open to mathematics majors for math elective credit. 3 lecture/problems. Prerequisite: C or better in MAT 215, or consent of instructor.

MAT 321 Introduction to Topology (4)

Topology of the line and plane, topological spaces, continuity and topological equivalence and topics selected from the following: bases and subbases, metric and normed spaces, countability axioms, separation axioms, compactness, connectedness, product spaces, completeness and function spaces. 4 lecture/problems. Prerequisite: C or better in MAT 310, or consent of instructor.

MAT 325 Introduction to the Theory of Numbers (4)

Fundamentals of the system of integers, divisibility, congruences, theorems of Fermat and Wilson, power residues and indices, quadratic reciprocity, factorization techniques, diophantine equations, theorems of Euler, Gauss and Lagrange. Elementary results concerning the distribution of primes. 4 lecture/problems. Prerequisite: Junior standing or consent of instructor.

MAT 330 Modern Euclidean Geometry (4)

Euclidean geometry using modern techniques of transformations, inversions. Extension of elementary geometry to elegant results on triangles, circles, polygons, famous theorems of geometry, unsolved problems. Introduction to deductive reasoning and techniques of proof. 4 lecture/problems. Prerequisite: Consent of instructor.

MAT 370 Graph Theory (4) FWSp

The study of graphs, trees, Eulerian, Hamiltonian, planar graphs, connectivity, coloring, independence and covering numbers, directed graphs, theorems of Menger, Ramsey with applications. 4 lecture/problems. Prerequisite: Consent of instructor.

MAT 380 Mathematics of Operations Research (4)

Introduction to mathematics of linear programming (LP): algebra and geometry of simplex method, solution of LP problems by Gauss-Jordan elimination method. Duality theory and sensitivity analysis. Development of revised and dual simplex algorithms. Introduction to parametric and separable convex programming. Applications of LP: computational considerations, case studies. 4 lecture/problems. Prerequisites: C or better in MAT 208 and 215, or consent of instructor.

MAT 381 Mathematics of Operations Research (4)

Solution of transportation, transshipment and assignment problems. Formulation and solution of network problems: maximal flow, minimal spanning tree, shortest route problems; PERT-CPM techniques. Introduction to dynamic and integer programming. Elements of game theory, solution of games by linear programming. Introduction to non-linear programming: Kuhn-Tucker conditions, quadratic and convex programming; SUMP solution procedure. 4 lecture/problems. Prerequisite: C or better in MAT 380, or consent of instructor.

MAT 382 Mathematics of Operations Research (4)

Introduction to Markov queuing models, including development of relevant probability and statistics; estimation of parameters in queing decision models. Inventory models and forecasting. Introduction to Markov processes and their application to Markov decision models. Introduction to mathematics of reliability. Decision making with experimentation, Bayes' procedure. Generation of random numbers and simulation models. 4 lecture/problems. Prerequisites: C or better in MAT 208, MAT 214 and STA 330 or 309 or 315 or 326, or consent of instructor.

MAT 391 Elementary Mathematics from an Advanced Viewpoint (4)

Development of the real number system through the reals; development of numeration systems; elementary concepts of algebra; introduction to number theory; elementary group and field theory. Development of problem solving strategies and application of technology to these topics. 4 lecture-problem. Prerequisite: C or better in MAT 191. Not open to mathematics majors for math elective credit.

MAT 392 Elementary Geometry from an Advanced Viewpoint I (4)

Introduction to Metric and non-Metric geometry; development of inductive and deductive geometric proofs; congruence and similarity; and basic concepts of topology. 4 lecture-problems. Prerequisites: C or better in MAT 391.

MAT 400 Special Problems for Upper Division Students (1-2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

MAT 401 Numerical Analysis (4) F (odd years)

Theoretical error and machine error associated with algorithms. Solutions of non-linear equations, systems of linear equations and systems of non-linear equations. 4 lecture/problems. Prerequisite: C or better in MAT 201, MAT 208, MAT 215 and CS 120 or CS 125 or consent of instructor.

MAT 402 Numerical Methods in Differential Equations (4) W (even years)

Polynomial interpolation, cubic splines, numerical differentiation and integration, numerical solutions of differential equations including Runga-Kutta methods and predictor-corrector methods for solving initial value problems and the shooting method for solving boundary value problems. 4 lecture/problems. Prerequisites: C or better in MAT 216 and MAT 401 or CS 301 or consent of instructor.

MAT 413 Advanced Calculus (4)

Differential and integral calculus of functions and transformations in several real variables. 4 lecture/problems. Prerequisite: C or better in MAT 315, or consent of instructor.

MAT 415 Foundations of Geometry (4)

Axiomatic development of selected topics from euclidean and neutral geometries; introduction to non-euclidean geometry with emphasis on the hyperbolic case. 4 lecture/problems. Prerequisite: C or better in MAT 208 and 215, or consent of instructor.

MAT 416 Projective Geometry (4)

Synthetic and analytic treatment of selected topics from projective geometry; classical theorems, conics, polarities; quadratic and bilinear forms. 4 lecture/problems. Prerequisite: C or better in MAT 208 and 215, or consent of instructor.

MAT 417, 418 Modern Algebra (4) (4)

Introduction to algebraic structures; groups, rings, integral domains, fields; mappings with emphasis on morphisms. 4 lecture/problems. Prerequisite for MAT 417: C or better in MAT 310 or consent of instructor. Prerequisite for MAT 418: C or better in MAT 417 or consent of instructor.

MAT 419 Abstract Linear Algebra (4)

Vector spaces and dimension, linear transformations, dual spaces, adjoints of transformations, multilinear forms, eigen vectors, the Cayley-Hamilton theorem, inner product spaces, orthogonality, similarity transformations, the spectral theorem, jordan form. 4 lecture/problems. Prerequisite: C or better in MAT 208, or consent of instructor.

MAT 420 Differential Geometry (4)

The Frenet formulas, covariant derivatives, frame fields, the structure equations, differential forms on a surface, normal curvature, Gaussian curvatures; intrinsic geometry of surfaces in E3, the Gauss and Bonnet theorem. 4 lecture/problems. Prerequisite: C or better in MAT 314 and MAT 216, or consent of instructor.

MAT 428, 429 Functions of a Complex Variable (4) (4)

Algebra and geometry of complex numbers; analyticity, mappings of elementary functions; Cauchy integral formula, Taylor and Laurent series, the residue theorem; conformal mapping with applications. 4 lectures/problems. Prerequisites for MAT 428: C or better in MAT 314 or consent of instructor. Prerequisite for MAT 429: C or better in MAT 428 or consent of instructor.

MAT 431, 432 Differential Equations (4) (4)

Partial differential equations with applications to wave actions, heat transfer and fluid flow. Ordinary differential equations; linear with variable coefficients, linear systems; stability and qualitative behavior of solutions. 4 lecture/problems. Prerequisite: C or better in MAT 216 and 208 or consent of instructor.

MAT 444 Vector and Tensor Analysis (4)

An integrated course in the algebra and calculus of vectors and tensors; topics in differential geometry; applications to mechanics of deformable media, hydrodynamics, general relativity. 4 lecture/problems. Prerequisite: C or better in MAT 208 and 216. PHY 321 is recommended, or consent of instructor.

MAT 450 Foundations of Mathematics (4)

Introduction to axiom systems including consistency, independence, satisfiability and completeness; transfinite arithmetic; the continuum hypothesis; well ordering and its equivalents. 4 lecture/problems. Prerequisite: C or better in MAT 310 or consent of the instructor.

MAT 461, 462 Senior Project (2) (2)

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum of 120 hours total time.

MAT 463 Undergraduate Seminar (2)

Discussions through seminar methods of new developments in the fields of student's particular interests. 2 lecture/discussions. Prerequisite: Senior standing in mathematics.

MAT 470 Combinatorics (4) FWSp

Study of enumeration techniques, permutations, combinations, principle of inclusion and exclusion, finite fields, combinatorial designs, error-correcting codes. 4 lecture/problems. Prerequisite: C or better in Mat 208 or consent of instructor.

MAT 480 Mathematical Programming (4)

Treatment of linear inequalities, duality, general algorithms, application of linear programming. Introduction to discrete and nonlinear programming. 4 lecture/problems. Prerequisite: C or better in MAT 208 and CS 125, or 120, or consent of instructor.

MAT 485, 486 Mathematical Modeling and Simulation (4) (4)

Introduction to the general principles of modeling. Models will be selected from the areas such as physics, biology, political science, chemistry, engineering and business. Analytical, numerical and simulation methods will be used to solve the models. 4 lecture/problems. Prerequisites: C or better in the following courses: CS 120 or CS 125, MAT 201, MAT 208, MAT 216 and STA 330 or consent of instructor.

MAT 491 Elementary Geometry from an Advanced Viewpoint II (4)

Introduction to congruence and similarity through constructions and deductive proofs; motion geometry involving translations, rotations and flips; tesselations; topology; coordinate geometry programming in LOGO. 4 lecture/problems. Prerequisite: C or better in MAT 207. Not open to math majors for upper division mathematics elective credit.

MAT 492 Technological Applications in Mathematics (4)

Use of computers, microcomputers, calculators and other technologies in doing mathematics. Evaluation and utilization of instructional software in mathematics; use of application software including databases and spreadsheets; social issues related to microcomputer use. 4 lecture/problems. Prerequisite: C or better in MAT 491 or consent of instructor. Not open to math majors for upper division mathematics elective credit.

MAT 493 Algebraic Structures and Computing for Elementary and Middle School Teachers (4)

Development of algebraic structures from groups to fields. Study of modular arithmetic, relationships and functions. Use of the computer, including programming in BASIC, to investigate algebraic relationships and algorithms. 4 lecture/problems. Prerequisite: C or better in MAT 491 or permission of the instructor. Not open to math majors for upper division mathematics elective credit.

MAT 495/495A, 496/496A, 497/497A Topics in Contemporary Secondary Mathematics I, II, III (3/1) (3/1) (3/1)

Examination of the high school mathematics curriculum from an advanced viewpoint. Analysis of current issues and trends in secondary school mathematics. Use of technology in learning mathematics. Assessment of students' competency in mathematics. Field experiences in educational and non-educational settings. The first two quarters of the sequence are graded on a CR/NC basis and do not count as upper division math elective credit. 3 hours lecture, one two-hour activity. Prerequisites: Completion of 28 units of 300 and 400-level mathematics courses, including MAT 417, 325, 306 and a course in Geometry selected from MAT 330, 415, or 416 or the equivalent of these three courses.

MAT 499/499A/499L Special Topics for Upper Division Students (1–4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units with a maximum of 4 units per quarter. Prerequisite: consent of instructor. Lecture/Activity/Lab or combination of these.

STATISTICS

D. Singh Gill, *Coordinator*

STA 120 Statistics with Applications (4) FWSpSu

Collection and summarization of data; measures of central tendency and dispersion; probability; binomial and normal distributions, confidence intervals and hypothesis testing. Not open to mathematics or engineering majors. 4 lecture/problems. Prerequisites: ELM score of at least 550 or appropriate MDPT score or grade of "C" or better in MAT 012. Prerequisite must be met within two quarters.

STA 200 Special Problems for Lower Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

STA 210 Statistical Computing (4)

Use of computer packages, inferences about means of two populations, dependent and independent samples, small and large samples, inferences about proportions and variances, correlation and regression. 4 lecture/problems. Prerequisite: C or better in STA 120 or consent of instructor.

STA 220 Discrete Probability Models (4)

Set-theoretic approach to probability in finite sample spaces. Conditional probability, independence, binomial, hypergeometric and related distributions. 4 lecture/problems. Prerequisite: C or better in MAT 105, or consent of instructor.

STA 309 Statistical Methods in Engineering and the Physical Sciences (3) FWSpSu

The uses of statistics in testing, inspection and production, measures of central tendency and dispersion, probability, binomial and normal distributions, sampling theory, hypothesis testing and estimation, comparison of two populations. Not open to students required to take STA 315 or ECE 315. Not open to math majors for upper division math elective credit. 3 lecture/problems. Prerequisite: C or better in MAT 214 or MAT 131 or consent of instructor.

STA 310 Sampling Survey Methods (4)

Simple random sampling, stratified, cluster, systematic, multistage, multiphase and probability sampling methods, source of errors, sample size estimation. Not open to math majors for upper division math elective credit. 4 lecture/problems. Prerequisite: C or better in STA 120 or equivalent or consent of instructor.

STA 315 Probability and Statistics for Engineers (4) FWSpSu

Statistical and probabilistic concepts for the analysis of electrical and electronic systems associated with random phenomena. Application to communication, control, instrumentation and logic systems. Not open to math majors for upper division math elective credit. 4 lecture/problems. Prerequisite: C or better in MAT 215, or consent of instructor. Not open to students with credit in ECE 315, STA 309 or students required to take STA 330.

STA 320 Nonparametric Statistics (4)

Common nonparametric tests such as permutation tests, sign tests, Wilcoxon test, chi-square test and rank correlation tests. Null distributions and their approximations. 4 lecture/problems. Prerequisite: C or better in STA 210 or STA 331, or consent of instructor.

STA 326 Statistical Methods for Computer Scientists (4) FWSp

Rules of Probability. Discrete and continuous distributions including the multinomial distribution. Sampling distributions. Point and interval estimation. Hypothesis testing. Large and small sample inferences for means, proportions and variances. Introduction to queueing theory and regression. 4 lecture/problems. Prerequisites: C or better in MAT 214 or consent of instructor. Not open to students required to take STA 330.

STA 330 Applied Probability Theory (4) FW

Rules of probability, random variables, expected values of random variables, moment generating functions. Discrete and continuous probability distributions, including bivariate distributions, with applications. 4 lecture/ problems. Prerequisite: C or better in MAT 215. Not open to students with credit in STA 315 or ECE 315.

STA 331 Applied Statistics (4) WSp

Central limit theorem, maximum likelihood estimation. Point and interval estimation and hypothesis testing. Small and large sample inferences. Contingency table analysis and Chi-square tests. 4 lecture/problems. Prerequisite: C or better in STA 330, STA 315 or ECE 315, or consent of instructor.

STA 400 Special Problems for Upper Division Students (1–2)

Individual or group investigation, research, studies or surveys of selected problems. Total credit limited to 4 units, with a maximum of 2 units per quarter.

STA 430 Introduction to Random Processes (4)

General types of stochastic processes. Random walks, Poisson processes, counting processes, Markov chains and topics from other areas, such as Markov jump processes, Birth-death processes, Gaussian processes. 4 lecture/problems. Prerequisite: C or better in STA 315 or STA 330 or consent of instructor.

STA 432 Applied Regression Analysis (4)

Matrix approach to regression models, least square estimation, correlation, multiple regression, transformation of variables, analysis of residuals, multi-collinearity and auto-correlation. Use of computer packages for applied problems. 4 lecture/problems. Prerequisites: C or better in STA 331 and MAT 208 or consent of instructor.

STA 435 Analysis of Variance and Design of Experiments (4)

ANOVA techniques, computer solutions, randomized groups and blocks designs, interactions, analysis of covariance. Latin square, split-plot, simple and confounded factorial designs; treatment of missing data, incomplete block designs. 4 lecture/problems. Prerequisite: C or better in STA 331 or STA 441 or consent of instructor.

STA 440 Mathematical Statistics I (4)

Discrete and continuous probability distributions; moments, moment generating functions, special distributions, distributions of functions of random variables. 4 lecture/problems. Prerequisite: C or better in MAT 215, or consent of instructor.

STA 441 Mathematical Statistics II (4)

Asymtotic distributions; central limit theorem; point and interval estimation; completeness and sufficient statistics; Neyman-Pearson theory of testing hypotheses. 4 lecture/problems. Prerequisite: C or better in STA 440, or consent of instructor.

STA 499/499A/499L Special Topics for Upper Division Students (1-4)

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units with a maximum of 4 units per quarter. Prerequisite: consent of instructor. Lecture/Activity/Lab or combination of these.

Graduate courses are listed in the graduate section of the catalog.

PHYSICS

Steven W. McCauley, *Chair*

Antonio Aurilia	Robert T. Bush
Soumya Chakravarti	Barry H. Dorfman
Robert D. Eagleton	John Fang
John W. Jewett	Kai-Shue Lam
John Mallinckrodt	Harvey S. Leff
Mary E. Mogge	Roger L. Morehouse
Barton Palatnick	George W. Rainey
Peter B. Siegel	

The major in physics prepares students for careers as physicists with industry, government, in university laboratories and in teaching. . By suitably chosen electives, students may emphasize the interdisciplinary areas of biophysics, astrophysics, computational physics, health physics, geophysics, physical chemistry, engineering or mathematics.

Physics majors enjoy relatively small upper division classes spanning experimental and theoretical aspects of classical and modern physics. They each do a senior project under faculty supervision. Additionally, they are encouraged to participate in other independent or group study/research activities sponsored by individual faculty.

Students majoring in physics have the opportunity to join the honorary society, Sigma Pi Sigma. Additional information concerning membership can be obtained from the Physics Department.

For those planning a career as a secondary school teacher, a single subject credential in Science is required. This credential is obtained by completing coursework in Education and passing the National Teacher Examination. The latter can be waived by taking the courses listed in the Waiver Program. See the Director of the Education and Equity in Mathematics, Science and Technology.

CORE COURSES FOR MAJOR*

(Required of all students)

General Physics	.PHY	131	(3)
General Physics	.PHY	132	(3)
General Physics	.PHY	133	(3)
General Physics Lab	.PHY	151L	(1)
General Physics Lab	.PHY	152L	(1)
General Physics Lab	.PHY	153L	(1)
General Physics	.PHY	234	(3)
Elem Modern Physics	.PHY	235	(3)
General Physics Lab	.PHY	254L	(1)
Elem Modern Physics Lab	.PHY	255L	(1)
Fund of Math Phy	.PHY	308	(4)
Fund of Math Phy	.PHY	309	(4)
Physics of Elec & Mag	.PHY	314	(4)
Physics of Elec & Mag	.PHY	315	(4)
Mechanics	.PHY	321	(4)
Mechanics	.PHY	322	(4)
Thermal Physics	.PHY	333	(4)
Quantum Mechanics	.PHY	401	(4)
Quantum Mechanics	.PHY	402	(4)
Optics	.PHY	417	(3)
Optics Lab	.PHY	418L	(1)
Advanced Physics Lab	.PHY	430L	(1)
Solid State Physics Lab	.PHY	431L	(1)
Nuclear Physics Lab	.PHY	432L	(1)
Senior Project	.PHY	461	(2)
Senior Project	.PHY	462	(2)
Undergraduate Seminar	.PHY	463	(2)

* A 2.0 cumulative GPA is required in corecourses including option courses for the major in order to receive a degree in the major.

SUPPORT AND ELECTIVE COURSES

(Required of all students)

General Chemistry	.CHM	112	(3)
General Chemistry	.CHM	113	(3)
General Chemistry Lab	.CHM	152L	(1)
General Chemistry Lab	.CHM	153L	(1)
Pascal	.CS	120	(4)
or FORTRAN	.CS	125	(4)
Anal Geom. & Calc	.MAT	115	(4)
Anal Geom. & Calc	.MAT	116	(4)
Calc of Sev Variables	.MAT	214	(3)
Calc of Sev Variables	.MAT	215	(3)
Diff. Equations	.MAT	216	(4)
Advanced Electives			(12)

(To be chosen from upper division courses in Physics or related fields in consultation with advisor; at least 4 units of these must be in Physics.)

Free Electives. . . . . (15)

GENERAL EDUCATION COURSES

Area 1: (Pattern 2 recommended)

A.	Freshman English I	.ENG	104	(4)
B.	**Advocacy and Argument	.COM	204	(4)
C.	Select one course from this area			(4)

Area 2: ** Recommended Choice.

A.	Analytic Geom. & Calculus	.MAT	114	(4)
B.	General Chemistry	.CHM	111	(3)
	and General Chemistry Lab	.CHM	151L	(1)
C.	Life Science	.BIO	110	(3)
	and Life Science Lab	.BIO	111L	(1)
	or Basic Biology	.BIO	115/115L	(5)
D.	Select one course in consultation with advisor			(4)

Area 3:

A.	Select one course from this area	(4)
B.	Select one course from this area	(4)
C.	Select one course from this area	(4)
D.	Select one course from this area.	(4)
E.	Select one course from this area.	(4)
F.	Select one course from this area.	(4)
G.	Select one course from this area	(4)

Area 4:

Intro to American Government	.PLS	201	(4)
U.S. History	.HST	202	(4)

Area 5:

Select 8 units from the approved list. Recommended courses: HST 421, CHM 306 and MAT 306.

PHYSICS MINOR

College Physics	.PHY	121/141L	(4)
and College Physics	.PHY	122/142L	(4)
and College Physics	.PHY	123/143L	(4)
or			
General Physics	.PHY	131/151L	(4)
and General Physics	.PHY	132/152L	(4)
and General Physics	.PHY	133/153L	(4)
and General Physics	.PHY	234	(3)
and Elem Modern Physics	.PHY	235	(3)

A min. of 30 units in physics, including the above, must be taken, of which at least 12 units must be chosen from upper division courses and no more than 12 units may be at the 100-level. . . . . (30)

Course Descriptions

The quarters in which particular courses are offered are indicated by the F, W, Sp, Su notations. If a course is not given each year, then the year in which it will next be offered is also given.

PHY 102 Fundamentals of Physics (4) FWSpSu

Various theories of matter and energy and the principles and laws that describe their behavior and applications. Some special knowledge of modern science that will function in a socially desirable manner in the lives of students. 4 lectures. Prerequisite: A college math course. PHY 102 is not open to students who have credit for PHY 121 or 131. May be graded on CR/NC basis.

PHY 105/105L Physics of Musical Sound (4) Sp

The fundamentals of acoustics and its application to music—vibrations, wave, hearing, pure tones, complex tones, resonance, scales, consonance, and the physics of musical instruments. 3 lecture/ problems, 1 three-hour laboratory.

PHY 121 College Physics (3) FWSpSu

A study of vectors, motion, forces, gravity, work and energy, momentum, angular motion and mechanical properties of matter. 3 lecture/problems. Not for students majoring in physics or engineering. Prerequisite: MAT 106 or equivalent. Corequisite: PHY 141L.

PHY 122 College Physics (3) FWSpSu

Heat, wave motion, sound, light and optical devices. 3 lecture/problems. Prerequisite: PHY 121 and PHY 141L. Corequisite: PHY 142L.

PHY 123 College Physics (3) FWSpSu

Electricity and magnetism, DC and AC circuits, electronics, atomic and nuclear physics. 3 lecture/problems. Prerequisite: PHY 122 and PHY 142L. Corequisite: PHY 143L.

PHY 131 General Physics (3) FWSpSu

Fundamental principles of mechanics, vectors, statics, uniform motion, accelerated motion, work and energy, rotational motion and fluid mechanics. 3 lecture/problems. Prerequisites: MAT 114. Corequisite: MAT 115 and PHY 151L.

PHY 132 General Physics (3) FWSpSu

Fundamental principles of harmonic motion, waves, rotational dynamics, thermodynamics, kinetic theory and optics. 3 lecture/ problems. Prerequisites: PHY 151L and C- or better in PHY 131. Corequisites: MAT 116 and PHY 152L.

PHY 133 General Physics (3) FWSpSu

Fundamental principles of electricity and magnetism. Coulomb's law, electric fields, potential, properties of dielectrics, capacitance, Ohm's law, magnetism and magnetic fields, measuring instruments, magnetic field of moving charges, induced emf, AC circuits. 3 lecture/problems. Prerequisites: PHY 151L and C- or better in PHY 131. Corequisite: PHY 153L and MAT 116.

PHY 141L, 142L, 143L College Physics Laboratory (1) (1) (1) FWSpSu

Laboratory to accompany College Physics lecture series. Experiments in mechanics, hydrostatics, wave motion, thermodynamics, optics, electricity and magnetism, and atomic and nuclear physics. 1 three-hour laboratory. To be taken in sequence concurrently with PHY 121, 122, 123, respectively.

PHY 151L, 152L, 153L General Physics Laboratory (1) (1) (1) FWSpSu

Laboratory to accompany General Physics lecture series. Experiments in mechanics, hydrostatics, wave motion, thermodynamics, optics, and electricity and magnetism. 1 three-hour laboratory. To be taken concurrently with PHY 131, 132, 133, respectively.

PHY 200 Special Problems for Lower Division Students (1-2) FWSpSu

Individual or group investigation, research, study or survey of selected problems. Approval of problem must be obtained in the Physics Department office prior to enrollment. Total credit limited to 4 units with a maximum of 2 units per quarter.

PHY 234 General Physics (3) W

Electromagnetic oscillations, Maxwell's equations and electromagnetic waves, geometric optics, physical optics, special theory of relativity. 3 lecture/problems. Prerequisite: PHY 132, 133. Corequisite for physics majors: PHY 254L.

PHY 235 Elementary Modern Physics (3) Sp

Origin of the quantum theory; Bohr theory; wave mechanics and atomic structure; introduction to nuclear physics. 3 lecture/problems. Prerequisite: PHY 234. Corequisite for physics majors: PHY 255L.

PHY 254L General Physics Laboratory (1) W

Experiments on optics and electromagnetism. 1 three-hour laboratory. Must be taken concurrently with PHY 234.

PHY 255L Elementary Modern Physics Laboratory (1) Sp

Experiments illustrative of modern physics. 1 three-hour laboratory. Must be taken concurrently with PHY 235.

PHY 299, 299A, 299L Special Topics for Lower Division Students (1-4) FWSpSu

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of instructor. Instruction is by lecture, laboratory or a combination of both.

PHY 301 Energy and Society (4)

Study of how humans use energy, including solar, nuclear, and other sources, to generate electricity, power vehicles, manufacture products, and the like, Emphasis is on elementary physics principles. Coverage includes a historical overview of societal energy use, the study of how energy is stored and transferred, advantages and disadvantages of renewable and nonrenewable resources, how fuels can be conserved, and how energy processes affect the environment. Prerequisite: One college level physics lecture course.

Phy 302 Physics of Everyday Experience

Investigation into the physics associated with experiences in everyday life. Areas of physics covered will include energy, waves, electromagnetism and optics. Applications of principles to common phenomena - weather, sound, aurorae, rainbows, halos, glories and the like. Applications of the principles to relevant social issue s- thermodynamics of global warming; propagation of earthquake waves and effects on building vibrations; principles involved in electromagnetic transportation, such as electric cars and magnetic levitation vehicles, optical principles associated with optical communication. Prerequisite: One college level physics lecture course.

PHY 304, 304L Electronics for Scientists (3) (1) F

For students majoring in biological sciences, chemistry, geology and other scientific areas, as well as for physics majors. Basic concepts of electrical circuits and solid state devices. Circuit analysis and operation of instruments commonly encountered in science lab. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: PHY 123 or 133.

PHY 305, 305L Computer Interfacing for Scientific Data Logging (3) (1) W (even years)

The electronic technology needed to connect scientific equipment to digital computers, including field effect transistors as temporary storage elements, elementary digital logic, ADC circuits, DAC circuits and signal reconstruction compared to signal amplification. 3 lecture/problems, 1 three-hour laboratory. Prerequisite: PHY 304.

PHY 306 History of Physics (4) F

History of physics from Thales of Miletus to the present with special emphasis on 19th and 20th Century developments. 4 lectures. Prerequisite: PHY 235 or CHM 301, or equivalent.

PHY 308 Fundamentals of Mathematical Physics (4) F

Applications of mathematical tools to problems in the study of electromagnetism, mechanics and quantum mechanics. Linear algebra, coordinate systems, vector analysis, ordinary differential equations, Fourier series. 4 lecture/problems. Prerequisites: PHY 235, MAT 215, 216.

PHY 309 Fundamentals of Mathematical Physics (4) W

Continuation of PHY 308. Applications of gamma, beta and error functions; functions of a complex variable; partial differential equations and boundary value problems; series solutions of ordinary differential equations in physics problems. 4 lecture/problems. Prerequisite: PHY 308.

PHY 310 Fundamentals of Mathematical Physics (4) Sp (even years)

Continuation of PHY 308 and 309. Applications of calculus of variations, tensor analysis, integral transforms, probability and statistics to physics problems. 4 lecture/problems. Prerequisite: PHY 309.

PHY 314, 315 Physics of Electric and Magnetic Phenomena (4) (4) WSp

Electrostatics, magnetostatics, circuit theory, time-varying fields, Maxwell's equations and electromagnetic waves. 4 lecture/problems. Courses to be taken in sequence. Prerequisite: PHY 308, PHY 309 (latter may be taken concurrently with PHY 314).

PHY 321, 322 Mechanics (4) (4) WSp

Vector algebra, principles of Newtonian mechanics, conservative forces, harmonic motion, central-force motion, the two-body problem, center of mass coordinates, statics and dynamics of rigid bodies, accelerated coordinate systems, normal coordinates and Lagrange's equations. 4 lecture/problems. Courses to be taken in sequence. Prerequisite: PHY 308, PHY 309 (latter may be taken concurrently with PHY 321).

PHY 333 Thermal Physics (4) F

Fundamental principles of thermodynamics and kinetic theory of gases. 4 lecture/problems. Prerequisite: PHY 132 and MAT 215, 216.

PHY 340 Energy and the Environment (4) Sp (even years)

Alternative energy technologies with a critical evaluation of their potential for solving the energy crisis and their impact on the environment. Natural resources, energy storage and transport, pollution, radiation hazards, energy conservation efforts, and outlook. 4 lecture/problems. Prerequisite: PHY 132 or PHY 122 and a calculus course.

PHY 344 Applied Optics (4) F

Geometrical optics and wave optics with an emphasis on technological applications. 4 lecture/problems. Prerequisite: PHY 122 or 132.

PHY 346 Solid State Physics for Engineers (4) F

Survey of modern physics and solid state physics principles and engineering applications. Emphasis on electronic properties of semiconductors. Not open to students in the B.S. physics program (physics/engineering double majors and physics minors excepted). 4 lecture/problems. Prerequisite: PHY 133.

PHY 400 Special Problems for Upper Division Students (1–2) FWSpSu

Individual or group investigation, research, study or survey of selected problems. Approval of problem must be obtained in the Physics Department office prior to enrollment. Total credit limited to 4 units with a maximum of 2 units per quarter.

PHY 401, 402 Quantum Mechanics (4) (4) FW

Introduction to quantum mechanics, including Schroedinger equation, hydrogen atom, degeneracy, perturbation theory, multi-electron atoms, matrix mechanics. 4 lecture/problems. Prerequisites: PHY 235 or CHM 313, and PHY 309.

PHY 403 Advanced Quantum Mechanics (4) Sp

Advanced topics in quantum mechanics, including approximation methods, time-dependent perturbation theory, relativistic theory and frontiers. 4 lecture/problems. Prerequisite: PHY 402.

PHY 404 Introduction to High Energy Physics (4) Sp (odd years)

History and concepts of high energy and elementary particle physics; fundamental interactions; quantum numbers, invariance principles and conservation laws; SU(3) quark model and QCD; particle detectors and accelerators. 4 lectures. Prerequisites: PHY 401, 402.

PHY 406 Solid State Physics (4) W

Crystallography, crystal imperfections, diffusion. Metals, ionic crystals, covalent crystals, molecular crystals. Transport properties and specific heat of metals. Electronic states in solids, physical properties of semiconductors, theory of semiconductor devices. Behavior of dielectrics, magnetism and superconductors. 4 lecture/problems. Prerequisite: PHY 235 and PHY 309.

PHY 407 Statistical Physics (4) W (odd years)

Study of the statistical behavior of physical systems composed of large numbers of similar particles. Derivation and application of the distribution functions for the cases of Maxwell-Boltzmann statistics. Bose-Einstein statistics and Fermi-Dirac statistics. 4 lecture/problems. Prerequisite: PHY 235, 333 and MAT 215.

PHY 409 Computational Physics (4) F

Computational methods, which include numerical integration, the solution of differential and transcendental equations, and statistical analysis, are applied to problems in mechanics, electromagnetism, quantum mechanics and non-linear dynamics. 4 lecture/problems. Prerequisites: PHY 235, 309 and CS 120 or 125.

PHY 410 Biophysics (4) W (odd years)

Concepts and mechanisms involved in the interpretation of biological systems. A description of living processes in physical terms. (See also BIO 410) 4 lecture/problems. Prerequisite: PHY 123, or PHY 132 and 133.

PHY 417 Optics (3) Sp

Mirrors, lenses and optical instruments; interference, diffraction, polarization and elements of spectroscopy; lasers and holography. 3 lecture/problems. Prerequisite: PHY 234. Corequisite for physics majors: PHY 418L.

PHY 418L Optics Laboratory (1) Sp

Laboratory to be taken concurrently with PHY 417. One 3-hour laboratory.

PHY 420 Acoustics (4) Sp (odd years)

The fundamentals of acoustical vibrations, baffle effects, resonance and filters, and transmission phenomena will be presented using differential equations and complex variables. 4 lecture/problems. Prerequisites: PHY 132 and MAT 215, 216.

PHY 422 Plasma Physics (4) F (even years)

Fundamental concepts and ideas in the study of ionized gases, including orbit theory, the "two-fluid" equations, magnetohydrodynamics and the Vlasov theory. Plasma phenomena, such as waves, diffusion, equilibrium, stability and others. 4 lecture/problems. Prerequisite: PHY 314.

PHY 424 Astrophysics (4) F (odd years)

Basic astrophysical data, stellar atmospheres and spectra, stellar structure and evolution, galactic structure and interstellar matter, galaxies and cosmology. 4 lecture/problems. Prerequisite: PHY 235.

PHY 425 Space Physics (4) W (even years)

Planetary motions, gravitation, celestial mechanics, interplanetary space missions, techniques of space borne planetary observation, planetary physics. 4 lecture/problems. Prerequisites: PHY 235, 321 (may be taken concurrently).

PHY 426 Relativity, Gravity and Black Holes (4) Sp (even years)

Review of special relativity, principle of equivalence, tensors, the metric tensor, general theory of relativity, cosmological models, gravitational waves, black holes, Hawking radiation, quantum gravity, connection with elementary particle theories. 4 lecture/problems. Prerequisite: PHY 235, 315 (may be taken concurrently), 322 (may be taken concurrently).

PHY 430L Advanced Physics Laboratory (1) FW

Topics in advanced experimental physics with emphasis on electromagnetism and mechanics. One 3-hour laboratory. Prerequisites: PHY 235, 255L, 315, 322. (PHY 430L, 431L and 432L may be taken in any order.)

PHY 431L Solid State Physics Laboratory (1) FW

Topics in experimental solid state physics. One 3-hour laboratory. Prerequisites: PHY 235, 255L, 315, 322. (PHY 430L, 431L and 432L may be taken in any order.)

PHY 432L Nuclear Physics Laboratory (1) FW

Topics in experimental nuclear physics. One 3-hour laboratory. Prerequisites: PHY 235, 255L, 315, 322. (PHY 430L, 431L, and 432L may be taken in any order.)

PHY 441 Internship in Physics (2) FWSpSu

Practical, on-the-job training and work experience in physics. Approval of Physics Department Chair required prior to enrollment. Course grade determined by internship coordinator and on-job supervisor. Total credit limited to 6 units.

PHY 461, 462 Senior Project (2) (2) FWSpSu

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results presented in a formal report. Approval of Physics Department Chair required prior to enrollment.

PHY 463 Undergraduate Seminar (2) Sp

Study of current developments in physics and discussion of periodicals of an appropriate level. 2 lecture/discussions. Prerequisite: PHY 234.

PHY 499/499A/499L Special Topics for Upper Division Students (1–4) FWSpSu

Group study of a selected topic, the title to be specified in advance. Total credit limited to 8 units with a maximum of 4 units per quarter. Prerequisite: consent of instructor. Instruction is by lecture, laboratory or a combination of both.

PHY 550 Seminar in Physics (1–3)

Special problems in selected areas of physics. Seminar, 1 to 3 hours. Maximum of 6 units may be earned.

INSTITUTE FOR ADVANCED SYSTEMS STUDIES

One of the Minors offered in the College of Science is Comparative Systems Analysis. It is also offered as a Certificate Program through the Kellogg-West Continuing Education Program.

Len Troncale, *Coordinator, Minor; Director, Institute*

Fellows of the Institute:
Bernard Banks (Math)
David Berry (Geology)
Soumya Chakravarti (Physics)
Carlos Ford-Livene (Math)
Larry Herber (Geology)
John Lyle (Land. Arch.)
Frank Mathur (Math)
Steve McCauley (Physics)
Carl Rathman (Engineering)
Len Troncale (Biology)

Chuck Amelin (Math)
Mark vonWodtke (Land. Arch.)
Richard DeNouvellis (Educ.)
Dhanwant Gill (Math)
Chung Lee (Computer Sci.)
Jim Manley (Philosophy)
Walter Maya (Chemistry)
Ron Quinn (Biology)
Harold Schleifer (Library)

With Associate Fellows: Mike Hamilton (Ecology); Albert Wilson (Astronomy & Math); and Donna Wilson (Psychology & Math)

The Institute offers interdisciplinary courses for general purposes as well as leading to the Minor and Certificate in Comparative Systems Analysis. The Minor is designed to complement a wide variety of major fields from the various schools in the University. The diverse specialties of Systems Analysis in Business, Management, Information Systems, Computer Systems, Environmental Design fields and Engineering constitute the fastest growing job category in the United States over the next decade according to government statistics. Students completing this Minor in conjunction with a major in their specialty fields will have developed skills in high demand for analyzing complex modern societal problems. Coursework in this Minor emphasizes the pure science aspects of systems; it focuses on what might be called the special theoretical knowledge of systems fundamental to the many practical applications mentioned above. Lab and field experiences in the Minor focus on application of transdisciplinary techniques and methodology and expose the student to ideas and faculty from a broad spectrum of specialties unified by general systems analytic approaches. The Minor and Certificate in Comparative Systems Analysis requires the completion of a minimum of 32 units. Admission to the Minor and Certificate Programs is required previous to enrollment in these courses. Interested students should contact Dr. Troncale.

Course Descriptions

NOTE: For all courses which have both a lecture component and a laboratory component (e.g. CSA 201/201A), both components are corequisites; that is, they must be taken concurrently. All the following are taught by interdisciplinary teams of Institute Fellows.

CSA 201/201A Humans and the Environment—Resources (2/2)

The dynamic relationship between people and the earth's resources: a transdisciplinary approach to theory with problem-oriented activities emphasizing general systems concepts for synthesis and comparison. Uses the case study approach for depth.

CSA 202/202A Humans and the Environment—Organization (2/2)

How political, economic and cultural organizations and human values impact people, the uses of technology and people's relationship with the environment. A transdisciplinary approach to theory with problem-oriented activities emphasizing general systems concepts for synthesis and comparison. Uses the case study approach for depth.

CSA 300 History and Philosophy of Systems Science (4)

History and context of general systems theory from classical philosophy to the present; its tenets, strengths, weaknesses and relationship to conventional and design disciplines; the relevance of systems science to complex human problems. Survey of its literature, investigators, institutions and organizations. 4 lecture/discussions.

CSA 305 General Morphology (4)

General principles of morphology and their application to various fields. Dimensionless morphology in mathematics and the natural sciences. Mathematical structures and concepts developed morphologically to illustrate the method. 4 lectures. Prerequisite: approval of instructor.

CSA 309 Comparative Science of Origins (4)

Cross-disciplinary survey of the mechanisms of origin of most levels of living and nonliving systems using synthetic concepts to integrate the scientific evidence. Emergence of sub-atomic particles to clusters of galaxies; from the origins of consciousness to civilization. Impact of scientific findings on centuries-old philosophical debates and human values. 4 lecture/discussions.

CSA 310 Natural Systems Science: A Synthesis (4)

Strengths and limits of the scientific method and its differences between disciplines. Use of seven transdisciplinary processes to unify the learning, understanding and comparison of fundamental facts and theories in case studies of astronomy, physics, chemistry, biology, geology, computer science and mathematics & their impact on values. 4 lecture/discussions.

CSA 340/340A Systems Law as an Active Force (2/2)

Law applied to optimizing and correcting systems; survey of legislation and case law dealing with environmental problems. Emphasis on the special difficulties in writing laws of a multidisciplinary nature. 2 lectures, 2 two-hour activities including internship.

CSA 350/350A Multimetrics (2/2)

Techniques and methods of measurement systems; comparative uses of metrics; design and application of metrics to human and environmental problems. Emphasis on exploration of the application of metric principles to the evaluation of qualitative differences. 3 lectures, 1 two-hour activity. Prerequisite: Statistics.

CSA 411/411A General Systems Theory: Hierarchies (3/1)

Introduction to hypotheses of natural systems evaluation and optimization. Origins of hierarchical structure underlying established sciences on the astronomical, physical, chemical, biological, social and artificial levels. 3 lectures, 1 two-hour activity. Prerequisite: For students selecting mathematical approach BIO 115/115L, for others only BIO 110/111L.

CSA 412/412L General Systems Theory: Testing Hypotheses (3/1)

Identification of trends observable in level-to-level evolution of natural hierarchies; emphasizes rigorous testing of the validity of the general systems field axioms abstracted from these trends. 3 lectures, 1 two-hour activity. Prerequisite: CSA 411/411A.

CSA 413/413A General Systems Theory: Man-Made Systems (3/1)

Applications of systems field axioms to the study of man-made systems malfunctions. Use of axioms to engineer optimal societal systems. 3 lectures, 1 two-hour activity. Prerequisite: CSA 412/412A.

CSA 440 General Systems Modeling and Simulation (4)

Using isomorphies and systems-level computer simulation tools in modeling complex dynamical systems and their problems. Survey, comparison and training in use of STELLA, EXTEND, CAST and GENSYS with testing of their use of systems concepts. Evaluating global system models and their effects on decision makers. 4 lecture/discussions. Prerequisite: CSA 303 or 304.

CSA 450 Introduction to Systems Theory (4)

Evolution of systems approach to problem solving; comparative overview of systems methodology. Case studies illustrating successful versus unsuccessful applications of the systems approach to governmental, biological, social, economic and technological problems. 4 lectures. Prerequisite: STA 236.

CSA 451/451L Techniques of Systems Analysis (3/1)

Modeling of complex systems; analog and digital simulation; critical path methods; optimization methods; case studies illustrating applications of systems analysis techniques and design of new techniques. 3 lectures, 1 three-hour laboratory. Prerequisite: CSA 450.

CSA 470 Applied Ecosystems Engineering (4)

History, potential and critical analysis of applications of natural systems concepts to environmental systems engineering. Linked systems isomorphies, allometry, modeling and techniques applied to systems taxonomies of current large-scale environmental, energy and societal problems. 4 lecture/discussions. Prerequisites: BIO 325/325L; CSA 413/413A.

CSA 490 Seminar in Comparative Systems Analysis (1-4)

Special problems in selected areas of comparative systems analysis. Each seminar will have a subtitle describing its nature and content. Seminar, 1 to 4 hours. May be repeated for a maximum of 8 units. Prerequisite: consent of instructor.